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STUDY OF MAGNITUDES, SEISMICITY AND EARTHQUAKE DETECTABILITY USING A GLOBAL NETWORK

Frode Ringdal

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Center for Seismic Studies
1300 N. 17th Street, Suite 1450
Arlington, Virginia 22209-3871
Telephone: (703) 276-7900

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Study of magnitudes, seismicity and earthquake detectability using a global network.

Frode Ringdal
NTNF/NORSAR, N-2007 Kjeller, Norway

International Seismological Center

Summary

Based on 10 years of observations reported in the ~~ISC~~ bulletins (1971-1980), m_b magnitudes for about 70000 earthquakes have been recomputed using a maximum-likelihood estimation technique. Reportings from a network of 115 globally distributed stations were used in these calculations. Comparison to conventional m_b estimates show that the network magnitude bias problem is quite significant at low and intermediate magnitudes. Recurrence statistics based on the revised m_b estimates give b-values consistent with those obtained from LASA and NORSAR data, and indicate that the number of earthquakes worldwide of $m_b \geq 4.0$ averages about 7500 annually. The teleseismic detection capability of the network (requiring at least four detecting stations) has been estimated based on recurrence statistics. The estimated 90 per cent incremental m_b threshold ranges from 3.9-4.5 in the northern hemisphere, and from 4.2-4.8 in the southern hemisphere. This is consistent with results obtained by the 'Networth' approach.

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1. Introduction

The problem of bias in magnitudes estimated by a network of stations has been addressed in a number of investigations, e.g. Husebye *et. al.* (1974), Ringdal(1976), Evernden and Kohler (1976), Chinnery(1978), Christoffersson(1980), Elvers(1980) and Clark(1983). Most of these studies have concluded that the bias problem is indeed significant, especially at low magnitudes. The maximum-likelihood estimation technique described by Ringdal(1976) and Christoffersson(1980) has been shown to reduce the bias significantly. In this paper, this method is adapted to a global network of the type reporting to the International Seismological Centre (ISC), and is applied to 10 years of ISC data (1971-1980). The revised magnitudes thus obtained are compared to those obtained through conventional estimation techniques, and are also used to develop seismicity recurrence relations and to estimate network detection capability.

2. Method

The basic model used in this paper has previously been described in detail by Ringdal (1976) and Christoffersson (1980). For a seismic network of N stations, let g_i (i=1,2,...,N) denote the P-wave detection threshold in terms of log(A/T) of the i'th station. Furthermore, for a set of M seismic events of unknown "true" body wave magnitudes μ_j (j=1,2,...,M), let y_{ij} denote the P-wave signal level in terms of log(A/T) at the i'th station for the j'th event. Here, as

customary, A/T denotes zero-to-peak amplitude (nanometers) divided by signal period (seconds).

We assume that g_i and y_{ij} can be considered as sampled from normal (Gaussian) distributions as follows:

$$g_i \sim N(G_i, \gamma_i^2) \tag{1}$$

$$y_{ij} \sim N(\mu_j - Q_{ij} + B_i, \sigma_i^2) \tag{2}$$

Here:

G_i is the average station detection threshold in terms of log(A/T),
Q_{ij} is the Gutenberg-Richter (1956) distance-depth correction factor,
B_i is the average station magnitude bias,
γ_i and σ_i are standard deviations within the distributions.

For the j'th event, we will for the purpose of magnitude estimation consider only the subset of stations within the distance range 21-100 degrees. This is in accordance with procedures employed by the ISC. Based on actual ISC reportings, the stations are then further classified into three groups:

A_j : Stations reporting a P-detection with an associated log(A/T) value (y_{ij}).
B_j : Stations reporting a P-detection with no associated log(A/T).
C_j : Stations not reporting a P-detection for the event.

For group C_j ,the reasons for not reporting at all could be either that the signal was too weak to be detected, or that the station was inoperative at the particular time. Since we do not have access to the station operations records, it is necessary to treat this problem statistically, as was also done by Ringdal *et al.* (1977). Thus, we will denote by P_{ij} the probability that the i'th station was inoperative for the j'th event, given nondetection at that station.

Using a procedure similar to that described by Ringdal(1976), we can now derive a likelihood function $L(\mu_j)$ corresponding to the actually observed pattern of detections, nondetections and reported log(A/T) values for the j'th event, given that its true magnitude is μ_j :

$$L(\mu_j) = \prod_{i \in A_j} f_{ij}(\mu_j) \prod_{i \in B_j} h_{ij}(\mu_j) \prod_{i \in C_j} [1-P_{ij}][1-h_{ij}(\mu_j)] \tag{3}$$

where

$$f_{ij}(\mu_j) = \frac{1}{\sigma_i}\varphi\left(\frac{\mu_j - (y_{ij} + Q_{ij} - B_i)}{\sigma_i}\right) \tag{4}$$

$$h_{ij}(\mu_j) = \Phi\left(\frac{\mu_j - (G_i + Q_{ij} - B_i)}{\sqrt{\sigma_i^2 + \gamma_i^2}}\right) \tag{5}$$

Here, φ and Φ denote the standard normal probability density and cumulative distribution functions, respectively.

The maximum likelihood estimate of the event magnitude μ_j is obtained through numerically maximizing the likelihood function (3). However, before applying this procedure it is necessary to estimate the station parameters $G_i, B_i, \sigma_i, \gamma_i$ as well as the probability P_{ij}.

Estimates of G_i and γ_i for each station can be obtained through the procedure developed by Kelly and Lacoss (1969). The parameters B_i and σ_i will be estimated using the procedure of North (1977).

In order to estimate the probabilities P_{ij}, it is necessary to introduce some simplifying assumptions. Thus, we will assume that the *a priori* probability of any station being inoperative is a constant value P. Furthermore, for the j'th event, we will assume that all nondetecting stations have the same probability of being inoperative, i.e. $P_{ij}=P_j$. Let us for the j'th event denote by N_j the total number of network stations (within 21-100 degrees) and by K_j the number of these that did not report. We then set:

$$P_{ij}=P_j=\begin{cases} N_j P/K_j & \text{if } N_j P<K_j \\ 1 & \textit{otherwise} \end{cases} \quad (6)$$

Note that the larger the event, (i.e. the more stations that report), the more likely it becomes that a given nonreporting station is actually inoperative. The above procedure has the effect of adjusting the probability P_j so that the *conditional* expectation of the number of inoperative stations ($K_j P_j$) matches as closely as possible the *a priori* expectation ($N_j P$).

3. Station data.

The data base for this study consisted of the ISC reportings for the 10 year period 1971-1980. At any given time in this period, a typical number of about 1000 seismic stations reported observations to the ISC. An investigation of the station reports confirmed the conclusions of North (1977), who analyzed similar data for the period 1964-1973. Thus, the large majority of stations contribute very few observations, in particular of log(A/T), and would thus be of little use in this study.

For the purpose of magnitude estimation, we found it desirable to select a sub-network of about 100 globally distributed stations. The following basic criteria were applied:

a) Consistent reporting, preferably over the entire 10 years period
b) High detectability, i.e. a large number of teleseismic reports
c) A sufficient number of log(A/T) reports to estimate station parameters
d) Adequate geographical distribution.

Clearly, these criteria were sometimes in conflict. For example, several very sensitive stations, e.g. the large LASA array and some VELA arrays were only operational for part of the time period, but they were nevertheless selected. Also, the requirements were made less strict for stations in the southern hemisphere, in order to improve geographical coverage. Still, only a few useful stations could be found in Africa and South America. In the end, a total of 115 stations were selected, as listed in Table 1. At any time during the 10 years, about 100 of these were in actual operation.

Table 1 also summarizes estimates of the parameters G_i, γ_i, B_i and σ_i based on the procedures mentioned in the previous section. We note that in applying the Kelly-Lacoss (1969) procedure, a constrained value of β=2.0 was used. As shown by Chinnery and Lacoss (1976) such a constraint will have little effect on the estimated thresholds, but it serves to reduce the number of variables in the estimation procedure.

We further note that some stations reported log(A/T) for a low proportion of their detections. It is clearly possible that their detection threshold thus is significantly lower than their threshold for reporting log(A/T). This possibility was investigated for each station by comparing the average ISC event m_b for the total set of reported detections with the average m_b for the subset for which

log(A/T) was reported. As a first order approximation, we then adjusted the estimated thresholds according to the difference between these m_b values.

It should be observed that for some of the most sensitive stations, in particular some arrays, many of their reported detections are not associated with detected events in the ISC bulletin. Thus, the thresholds of Table 1 will be too high in these cases. In practice, this will make little difference in the maximum likelihood procedure since non-detections by these stations for ISC-reported events is usually due to the stations being inoperative. For array stations, we also note that reportings by sub-arrays or associated stations in some cases replaced the full array reporting.

4. Magnitude estimation results.

The previously described method and station network was applied to obtain maximum likelihood m_b estimates for ISC-reported events during 1971-1980. Known and presumed explosions were removed from the data set, so as not to bias the seismicity estimates. Furthermore, we restricted the data base to only those events which were reported by at least 4 stations of the 115 station network, and which had at least one detection in the distance range 21-100 degrees.

Since our network included most of the better stations reporting to the ISC, the resulting total of about 70000 events comprised nearly all those events for which any teleseismic reports were included in the ISC bulletins. However, it should be noted that these bulletins also include a large number of events reported by local stations only.

To simplify the calculations, we used in (3) constant values of $\sigma_i=0.35$ and $\gamma_i=0.20$, corresponding to the average values over all network stations (Table 1). Furthermore, based on reporting statistics for the largest events, we found a value of P=0.15 to be typical of the average down time of the stations. Simulation experiments showed that a very accurate value of P was not critically important, thus there was no reason to introduce variable P-values, e.g. depending upon year and epicentral region.

Figure 1 shows the resulting frequency-magnitude statistics for shallow events (depth < 60 km) globally. For comparison, similar statistics are also plotted using the magnitude estimation procedure currently employed by the ISC (i.e. averaging observed station magnitudes for all events with at least one log(A/T) report). The large difference in b-values (b=0.90 vs. b=1.40) illustrates the statistical bias resulting from using conventional magnitude estimation.

Figure 1 is quite similar to those obtained when comparing ISC magnitudes to magnitudes reported by sensitive array stations. (Chinnery,1978, Ringdal and Husebye, 1982). Average b-values obtained from array data for large epicentral regions are typically in the range 0.8-1.0, as demonstrated e.g. for LASA, b~0.84 (Dean,1972), for NORSAR, b~0.83 (Bungum and Husebye,1974) and for the VELA arrays, b~0.93 (Chinnery,1978). Thus, the results using maximum-likelihood estimation are in good agreement with array studies. However, it must be realized that b-values can show significant regional variations (Evernden,1970), and considerable caution in interpreting these data is therefore required.

Figures 2 and 3 shows incremental and cumulative statistics, respectively, averaged annually for shallow, intermediate and deep earthquakes. The slopes are approximately parallell, and have in the plots been constrained to the same value. The best-fitting cumulative relationships can be expressed as follows:

$$\log_{10}(N_C) = 7.33 - 0.90m_b \qquad D \leq 60km \tag{7}$$

$$\log_{10}(N_C) = 6.85 - 0.90m_b \qquad 60km < D \leq 300km \tag{8}$$

$$\log_{10}(N_C) = 6.13 - 0.90m_b \qquad D>300km \tag{9}$$

Here, N_C denotes the cumulative number of earthquakes, and D denotes depth of focus as given by the ISC. Thus, about 70 per cent of global earthquakes are shallow, 25 per cent of intermediate depth and 5 per cent deep. The estimated average annual number of earthquakes globally is about 7500 above m_b=4.0, and the number ranges between 6000 and 9000 for individual years within the ten year period.

The distribution of estimated m_b bias values compared to conventional m_b estimation is illustrated in Figures 4 and 5. In most cases, conventional m_b values are biased high by between 0. and 0.5 units. Figure 5 shows that the bias problem is most significant at intermediate magnitudes. As expected, the bias values decrease somewhat when three or more station reports are required for m_b determination, but are even then significant.

At high magnitudes, our approach gives essentially the same m_b values as those of the ISC. Thus, we have not taken into account the possibility of bias introduced by clipping of strong signals at some stations for such events (Chinnery,1978, von Seggern and Rivers,1978). While this problem is important in many contexts, it would not significantly influence the seismicity statistics and detectability estimates in this study.

5. Earthquake detectability.

Based on the estimated magnitude data, an attempt was made to estimate the global teleseismic detectability of shallow events for the 115 station network. For this purpose a regional subdivision of the Earth in grids of 15x15 degrees was made, and recurrence statistics for observed shallow earthquakes were considered within each grid area. The method of Kelly and Lacoss (1969) was then used to obtain detectability estimates for regions with sufficient number of observations, and approximate contours were drawn corresponding to these estimates.

Figure 6 shows the results for 90 per cent incremental probability of detection at at least four stations. It is seen that the thresholds vary from better than m_b=4.2 over much of the northern hemisphere to m_b=4.6 or higher in parts of the southern hemisphere. It must be noted that a considerable amount of smoothing and interpolation was necessary in generating Figure 6, and very detailed interpretation of these contours should therefore be avoided.

For comparison, the 'Networth' approach (Wirth,1970) was also applied to the network, using the threshold values of Table 1. The results are shown in Figure 7, and can be seen to be in good agreement with those of Figure 6. The actually observed differences are considered to be within the uncertainty limits of the estimation procedures employed.

In some earlier studies, e.g. the report CCD/558, theoretical detection capabilities of global networks were found to be inconsistent with actually reported magnitude data. It would appear that this inconsistency has been largely due to the network magnitude bias problem inherent in conventional magnitude estimation techniques.

The thresholds estimated in this paper relate to *average* operating conditions of the global network. Under special circumstances, the actual thresholds might be different, e.g. the thresholds would be higher immediately after a large earthquake and during a major aftershock sequence. For this reason, the estimated seismicity levels must also be interpreted with some caution.

As expressed by Ringdal(1976), the maximum-likelihood procedure ideally requires actual measurements of threshold levels at all nondetecting stations for any given event. The statistical approach to thresholds and station downtimes used here, has been chosen for practical reasons. However, it has been found by Ringdal(1976) and Christoffersson(1980) that even under very unfavorable circumstances, i.e. during a large aftershock sequence, the maximum-likelihood procedure, using estimated thresholds, produces acceptable results. Thus, while some individual events, in particular those occurring closely after a large earthquake would be affected by occasional errors in the thresholds, the effect on the total earthquake statistics should be insignificant.

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Station Code	Parameters				Station Code	Parameters			
	G	γ	B	σ		G	γ	B	σ
ADK	1.73	0.23	0.22	0.42	KRP	1.71	0.18	0.43	0.30
ALE	0.80	0.21	-0.10	0.30	KTG	1.00	0.25	-0.07	0.29
ALQ	0.78	0.24	-0.20	0.33	LAO	0.43	0.25	0.04	0.35
ARE	1.33	0.15	0.17	0.32	LEM	1.46	0.15	0.11	0.39
ASP	1.34	0.31	0.09	0.39	LOR	0.89	0.25	-0.08	0.33
BAG	1.71	0.17	0.26	0.32	LPB	1.17	0.21	0.18	0.35
BDF	1.07	0.16	0.11	0.35	LPS	1.18	0.16	0.12	0.38
BDW	0.71	0.22	-0.15	0.35	MAIO	0.87	0.18	-0.11	0.37
BHA	0.76	0.08	-0.25	0.32	MAT	1.15	0.19	-0.01	0.38
BJI	1.24	0.18	0.06	0.34	MAW	1.18	0.27	0.04	0.31
BKR	1.20	0.19	0.38	0.33	MBC	0.75	0.26	0.09	0.35
BLC	1.02	0.21	0.21	0.29	MIR	1.48	0.15	0.22	0.33
BMO	0.30	0.17	-0.28	0.35	MNG	1.44	0.22	0.11	0.39
BNG	0.75	0.18	0.01	0.41	MOX	0.98	0.12	0.07	0.25
BOD	1.01	0.12	-0.02	0.34	MOY	1.22	0.14	0.12	0.29
BUL	0.83	0.10	-0.05	0.29	MSO	0.97	0.22	-0.06	0.44
CAN	1.52	0.22	0.11	0.31	MTD	0.82	0.08	-0.12	0.30
CAR	1.45	0.13	0.14	0.40	MTN	1.26	0.24	-0.08	0.38
CHG	1.00	0.23	-0.06	0.36	MUN	1.69	0.24	0.19	0.36
CIR	0.77	0.07	-0.24	0.30	NAO	0.37	0.24	-0.10	0.33
CLK	0.81	0.08	-0.24	0.29	NDI	1.57	0.24	0.30	0.38
CLL	0.97	0.10	0.16	0.26	NEW	0.94	0.23	-0.07	0.39
COL	0.87	0.12	0.07	0.34	NUR	0.98	0.17	0.11	0.46
CPO	0.82	0.16	-0.02	0.35	NVL	1.47	0.30	0.23	0.35
CTA	1.23	0.20	0.07	0.39	OBN	1.33	0.17	0.39	0.33
DAG	0.92	0.15	0.08	0.32	PET	1.61	0.22	0.24	0.36
DUG	0.95	0.26	-0.04	0.31	PMG	1.70	0.16	0.27	0.38
EDM	1.25	0.11	0.43	0.28	PMR	0.97	0.25	-0.11	0.39
EKA	1.04	0.26	0.	0.29	PNS	1.15	0.23	0.11	0.50
ELT	1.15	0.20	0.15	0.34	POO	1.50	0.16	0.19	0.35
EUR	0.54	0.29	-0.36	0.47	PPI	1.46	0.18	0.08	0.41
FFC	0.91	0.23	0.09	0.30	PRE	0.93	0.09	-0.08	0.40
FRB	1.26	0.14	0.37	0.29	PSI	1.14	0.11	-0.02	0.38
FRU	1.39	0.13	0.35	0.33	QUE	1.13	0.18	0.21	0.46
FVM	1.23	0.29	0.25	0.43	RAB	1.90	0.21	0.37	0.43
GBA	1.03	0.29	-0.07	0.42	RES	0.81	0.15	0.04	0.33
GDH	1.26	0.29	-0.05	0.30	SCH	1.48	0.28	0.27	0.34
GRF	1.20	0.26	0.25	0.28	SES	1.31	0.13	0.42	0.28
GRR	1.06	0.22	0.04	0.26	SHL	1.48	0.13	0.22	0.33
GUA	2.18	0.25	0.43	0.40	SJG	1.50	0.18	0.19	0.35
HFS	0.80	0.22	0.13	0.35	SPA	1.21	0.31	0.16	0.37
HYB	1.37	0.17	0.28	0.32	STK	1.55	0.22	0.27	0.38
ILT	1.09	0.17	0.08	0.32	SVE	1.37	0.19	0.37	0.31
IMA	0.93	0.24	-0.16	0.36	TIK	0.99	0.20	0.03	0.37
INK	1.08	0.10	0.25	0.29	TOO	1.50	0.23	0.13	0.35
IPM	1.34	0.13	0.10	0.36	TPT	1.60	0.24	0.09	0.34
IRK	1.17	0.19	-0.03	0.31	TUC	0.92	0.27	-0.17	0.32
JAY	1.70	0.07	0.15	0.41	TUL	1.03	0.23	0.21	0.34
KBL	1.09	0.16	0.15	0.30	TUP	0.76	0.12	-0.35	0.40
KBS	1.35	0.14	0.12	0.32	TVO	1.80	0.22	0.19	0.29
KEV	1.01	0.11	0.05	0.31	UBO	0.42	0.25	-0.13	0.38
KHC	0.88	0.20	0.03	0.26	UPP	1.36	0.09	0.60	0.33
KHE	1.53	0.21	0.37	0.31	WRA	0.71	0.28	-0.20	0.44
KHO	1.69	0.23	0.59	0.35	YAK	1.63	0.20	0.43	0.34
KIR	1.36	0.09	0.61	0.25	YKC	0.99	0.18	0.08	0.34
KJF	0.92	0.10	0.16	0.28	YSS	1.40	0.19	0.20	0.41
KOD	1.33	0.19	0.18	0.35	ZAK	0.86	0.18	-0.11	0.33
KRA	1.34	0.13	0.32	0.29					

Table 1. Estimates of the parameters G_i, γ_i, B_i and σ_i as defined in the text for the 115 seismic stations selected for this study. Each station is identified by its station code as used by the ISC.

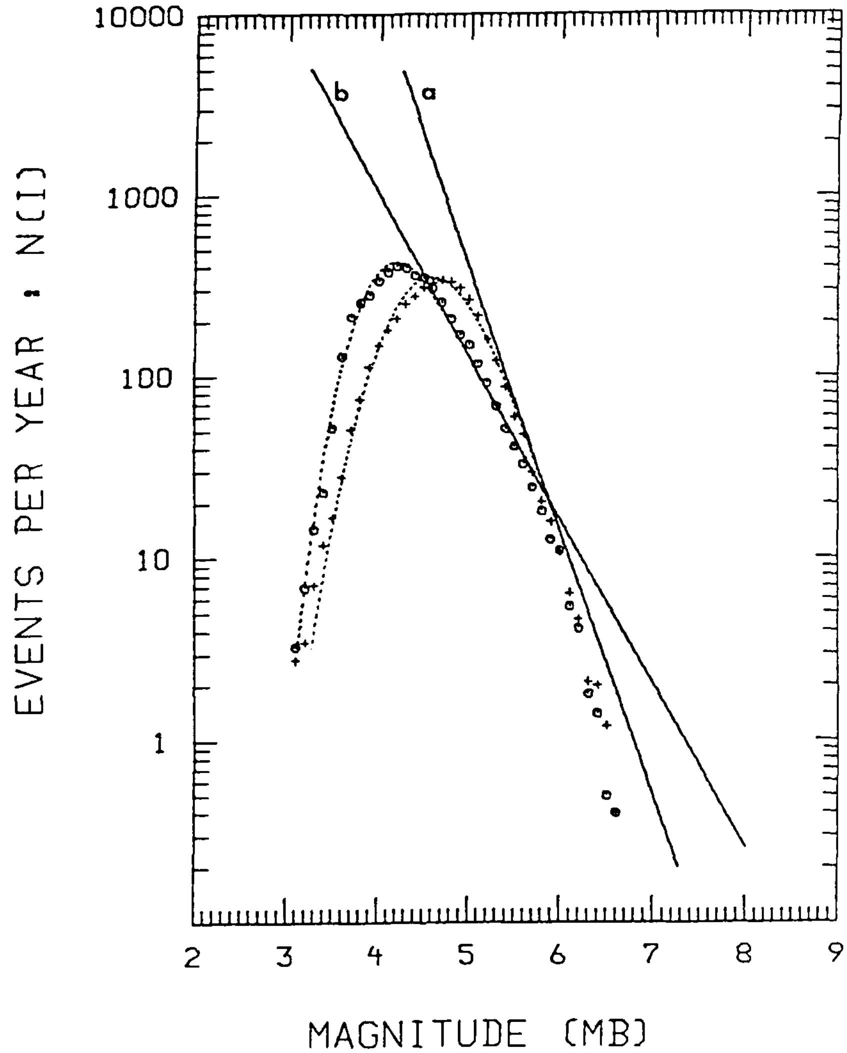


Figure 1. Incremental recurrence statistics for shallow events (averaged per year), (a) using conventional m_b (one or more station observations) and (b) using maximum-likelihood m_b. The dotted lines indicate the fit of the Kelly-Lacoss model. Note the significant difference in slopes between the two cases.

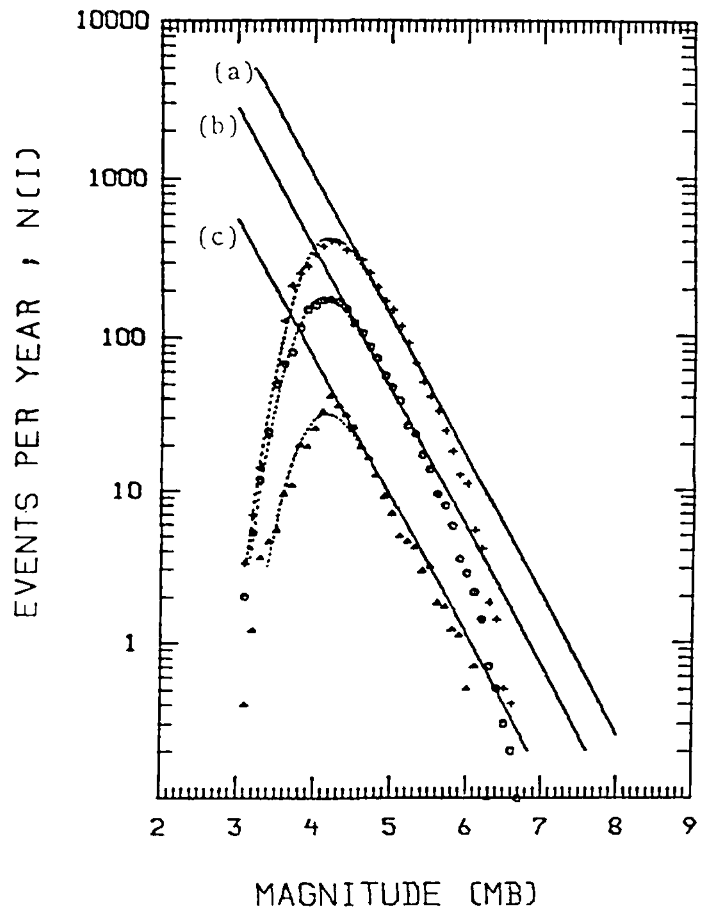


Figure 2. Incremental recurrence statistics averaged annually for (a) shallow, (b) intermediate and (c) deep earthquakes globally, using maximum likelihood m_b estimates.

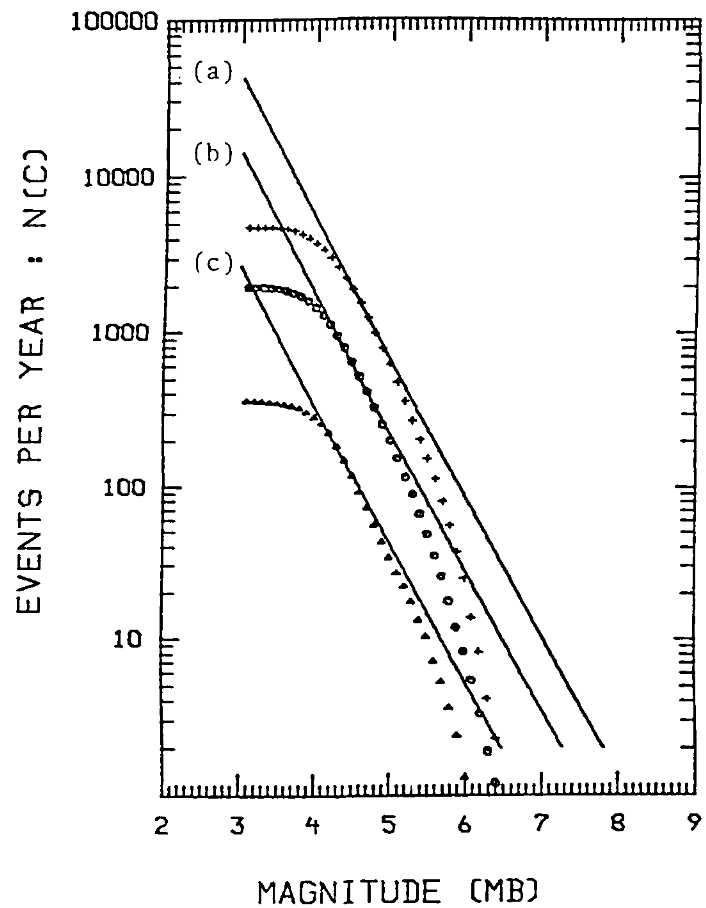


Figure 3. Cumulative recurrence statistics averaged annually for (a) shallow, (b) intermediate and (c) deep earthquakes globally, using maximum likelihood m_b estimates.

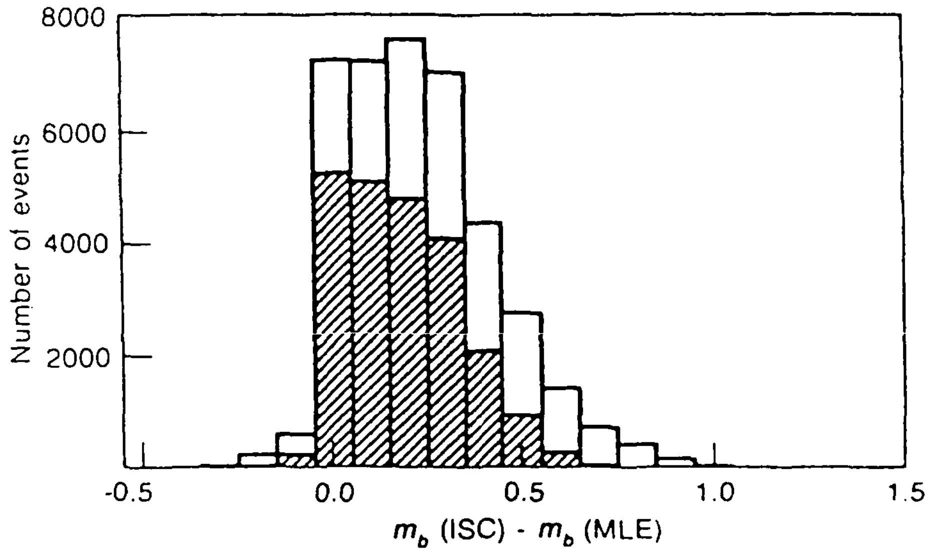


Figure 4. Distribution of differences between conventional m_b and maximum likelihood m_b. The filled columns correspond to requiring at least three observations in the conventional estimates.

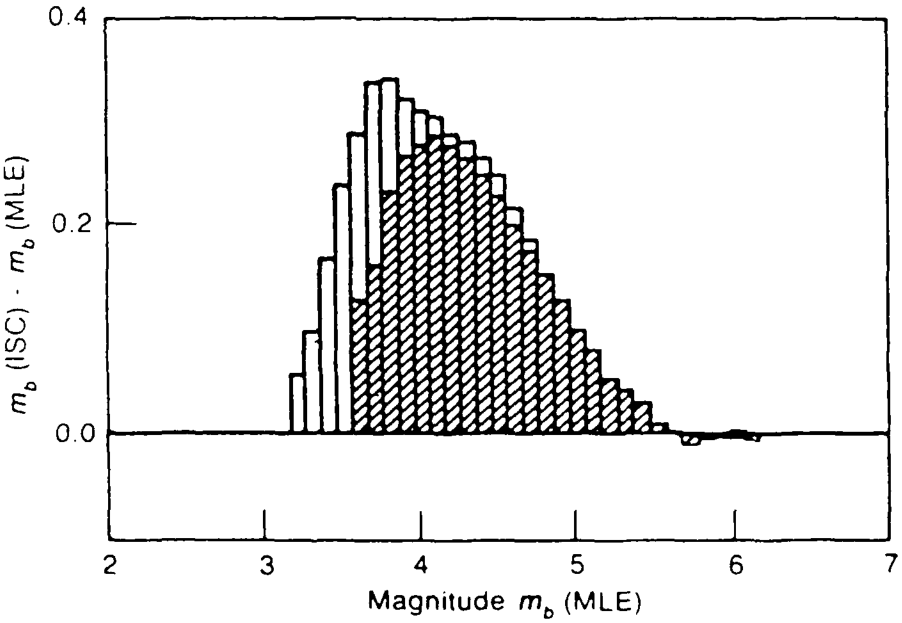


Figure 5. Average m_b differences (as in Figure 4) shown as a function of maximum likelihood m_b. Note that the bias is most pronounced at intermediate magnitudes.

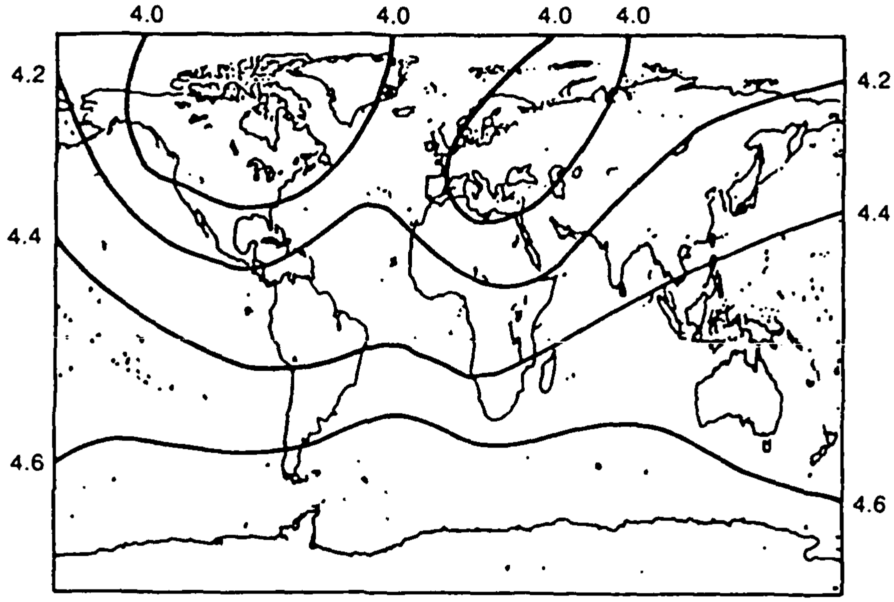


Figure 6. Contours corresponding to 90 per cent incremental probability of detection at at least 4 stations of the network, requiring at least 1 teleseismic detection. This figure is based on observed recurrence statistics using maximum-likelihood m_b.

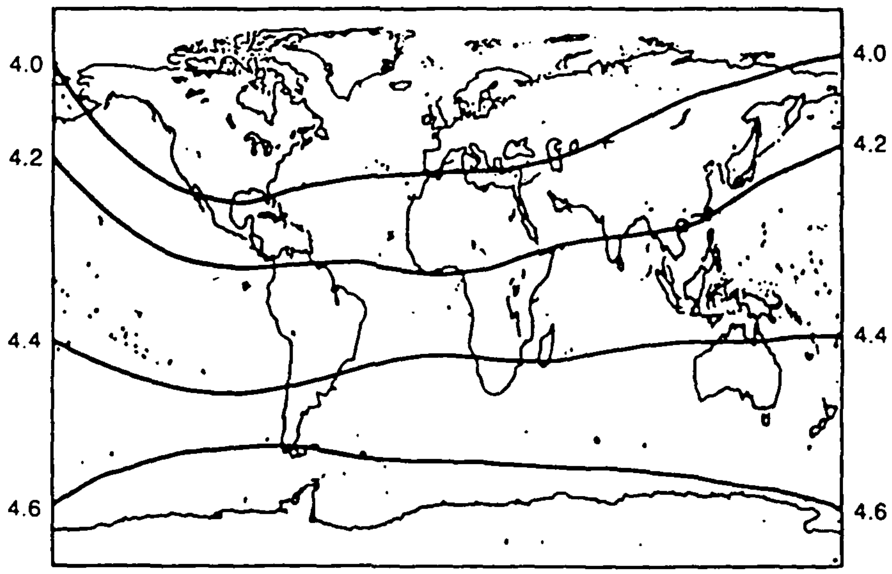


Figure 7. Contours corresponding to 90 per cent incremental probability of detection at at least 4 stations of the network, using the 'Networth' approach with threshold parameters as in Table 1.

Appendices

Appendix A: Station names and locations

Appendix B: Annual statistics of reported events

Appendix C: Examples of station threshold estimation

Appendix D: Magnitudes of presumed explosions 1971-1980

Appendix E: Data file formats

Appendix A

Station names and locations

In this Appendix, information for each of the 115 seismograph stations used in this study is summarized:

- Station number
- Station code (as used in the ISC bulletins)
- Station name
- Station location (geographical area)
- "W" if the station is part of the WWSSN
- Station latitude, degrees (- means south)
- Station longitude, degrees (- means west)
- Station altitude (meters)

Station no, name and location					Lat	Lon	Alt
1	ADK	Adak	Alaska and Aleutians		51.884	-176.684	116
2	ALE	Alert	Northwest Territories		82.483	-62.400	65
3	ALQ	Albuquerque	New Mexico	W	34.943	-106.457	1849
4	ARE	Arequipa	Peru	W	-16.462	-71.491	2452
5	ASP	Alice Springs	Northern Territory		-23.683	133.897	600
6	BAG	Baguio City	Luzon	W	16.411	120.580	1507
7	BDF	Brasilia Array (W)	Brazil	W	-15.664	-47.903	1255
8	BDW	Boulder	Wyoming		42.776	-109.568	2190
9	BHA	Broken Hill	Zambia		-14.447	28.468	1206
10	BJI	Beijing	Beijing		40.040	116.175	43
11	BKR	Bakuriani	Gruziya		41.733	43.517	1500
12	BLC	Baker Lake	Northwest Territories		64.317	-96.017	16
13	BMO	Blue Mountains	Oregon		44.849	-117.306	1189
14	BNG	Bangui	Central African Repu		4.435	18.547	378
15	BOD	Bodaibo	Irkutskaya		57.850	114.183	250
16	BUL	Bulawayo	Zimbabwe Rhodesia	W	-20.143	28.613	1341
17	CAN	Canberra	Australia		-35.321	148.999	700
18	CAR	Caracas	Venezuela	W	10.507	-66.928	1032
19	CHG	Chieng Mai	Thailand	W	18.790	98.977	416
20	CIR	Chiredzi	Zimbabwe Rhodesia		-21.013	31.580	430
21	CLK	Chileka	Malawi		-15.680	34.977	781
22	CLL	Collmberg	GDR		51.310	13.003	230
23	COL	College Outpost	Alaska and Aleutians		64.900	-147.793	320
24	CPO	Cumberland Plateau	Tennessee		35.595	-85.570	574
25	CTA	Charters Towers	Queensland	W	-20.088	146.254	357
26	DAG	Danmarks Havn	Greenland	W	76.770	-18.770	16
27	DUG	Dugway	Utah	W	40.195	-112.813	1477
28	EDM	Edmonton	Alberta		53.222	-113.350	730
29	EKA	Eskdalemuir Ar	Scotland		55.333	-3.159	263
30	ELT	Yel'tsovka	Altayskiy		53.250	86.267	-
31	EUR	Eureka	Nevada		39.483	-115.970	2178
32	FFC	Flin Flon	Manitoba		54.725	-101.978	338
33	FRB	Frobisher Bay	Northwest Territories		63.747	-68.547	18
34	FRU	Frunze	Kirgiziya		42.833	74.617	655
35	FVM	French Village	Missouri		37.984	-90.426	310
36	GBA	Gauribidanur Ar	Karnataka		13.604	77.436	686
37	GDH	Godhavn	Greenland	W	69.250	-53.533	23
38	GRF	Grafenberg Ar	Bayern		49.692	11.222	500
39	GRR	Gorron	Normandie		48.388	-0.858	220
40	GUA	Guam	Mariana Islands	W	13.538	144.912	230
41	HFS	Hagfors	Sweden		60.134	13.696	265
42	HYB	Hyderabad	Andhra Pradesh		17.417	78.553	510
43	ILT	Iul'tin	Magadanskaya		67.833	-178.800	-
44	IMA	Indian Mountain	Alaska		66.068	-153.679	-
45	INK	Inuvik	Northwest Territories		68.292	-133.500	40
46	IPM	Ipoh	West Malaysia		4.600	101.055	-
47	IRK	Irkutsk	Irkutskaya		52.272	104.310	467
48	JAY	Djajapura	West Irian,Indonesia		-2.500	140.667	400
49	KBL	Kabul	Afghanistan		34.541	69.043	1920
50	KBS	Kingsbay	Svalbard	W	78.917	11.924	46
51	KEV	Kevo	Finland		69.755	27.007	80
52	KHC	Kasperske Hory	Czechoslovakia		49.131	13.578	695
53	KHE	Kheis	Arkhangel'skaya		80.617	58.050	100
54	KHO	Khorog	Tadzhikistan		37.483	71.533	1850
55	KIR	Kiruna	Sweden		67.840	20.417	390
56	KJF	Kajaani	Finland		64.199	27.715	160
57	KOD	Kodaikanal	Tamil Nadu	W	10.233	77.467	2345
58	KRA	Krakow	Poland		50.058	19.940	223

Station no, name and location					Lat	Lon	Alt
59	KRP	Karapiro	North Island		-37.925	175.538	64
60	KTG	Kap Tobin	Greenland	W	70.417	-21.983	6
61	LAO	LASA Centre	Montana		46.689	-106.222	744
62	LEM	Lembang	Java	W	-6.833	107.617	1252
63	LOR	Lormes	Nivernais	W	47.268	3.859	520
64	LPB	La Paz	Bolivia	W	-16.533	-68.098	3292
65	LPS	La Palma	El Salvador	W	14.292	-89.162	1000
66	MAIO	Mashhad (SRO)	Iran		36.308	59.472	1150
67	MAT	Matsushiro	Nagano	W	36.542	138.207	407
68	MAW	Mawson	Mac Robertson Land		-67.604	62.871	12
69	MBC	Mould Bay	Northwest Territories		76.242	-119.360	15
70	MIR	Mirnyy	Queen Mary Land		-66.550	93.000	30
71	MNG	Mangahao	New Zealand		-40.619	175.482	396
72	MOX	Moxa	GDR		50.646	11.616	454
73	MOY	Mondy	Buryatskaya		51.683	100.983	-
74	MSO	Missoula	Montana		46.829	-113.941	1264
75	MTD	Mount Darwin	Zimbabwe		-16.780	31.583	967
76	MTN	Manton	Northern Territory		-12.846	131.131	155
77	MUN	Mundaring	Western Australia	W	-31.978	116.208	253
78	NAO	NORSAR A	Norway		60.824	10.832	379
79	NDI	New Delhi	Delhi	W	28.683	77.217	230
80	NEW	Newport	Washington		48.263	-117.120	760
81	NUR	Nurmijarvi	Finland	W	60.509	24.651	102
82	NVL	N'lazarevskaya	Dronning Maud Land		-70.767	11.833	87
83	OBN	Obninsk	Kaluzhskaya		55.167	36.600	-
84	PET	Petropavlovsk	Kamchatskaya		53.017	158.650	25
85	PMG	Port Moresby	Papua New Guinea	W	-9.409	147.154	67
86	PMR	Palmer	Alaska and Aleutians		61.592	-149.131	100
87	PNS	Penas	Bolivia		-16.267	-68.473	3986
88	POO	Poona	Maharashtra	W	18.533	73.850	560
89	PPI	Padang Panjang	Sumatera		-0.452	100.389	-
90	PRE	Pretoria	Transvaal		-25.753	28.190	1333
91	PSI	Prapat	Sumatera		2.691	98.919	-
92	QUE	Quetta	Pakistan	W	30.188	66.950	1721
93	RAB	Rabaul	New Britain	W	-4.191	152.170	184
94	RES	Resolute Bay	Northwest Territories		74.687	-94.900	15
95	SCH	Schefferville	Quebec		54.817	-66.783	540
96	SES	Suffield	Alberta		50.396	-111.042	770
97	SHL	Shillong	Assam	W	25.567	91.883	1600
98	SJG	San Juan (W)	Puerto Rico	W	18.112	-66.150	457
99	SPA	South Pole	Antarctica	W	-90.000	0.	2927
100	STK	Stephens Creek	New South Wales		-31.882	141.592	213
101	SVE	Sverdlovsk	Sverdlovskaya		56.810	60.637	275
102	TIK	Tiksi	Yakutskaya		71.633	128.867	25
103	TOO	Toolangi	Victoria		-37.571	145.491	604
104	TPT	Tiputa	Tuamotu		-14.984	-147.620	3
105	TUC	Tucson	Arizona	W	32.310	-110.782	985
106	TUL	Tulsa (Univ.Okla.)	Oklahoma		35.911	-95.792	261
107	TUP	Tupik	Central Siberia		54.433	119.900	-
108	TVO	Taravao	Tahiti		-17.782	-149.252	660
109	UBO	Uinta Basin Array	Utah		40.322	-109.569	1600
110	UPP	Uppsala	Sweden		59.858	17.627	14
111	WRA	Warramunga Ar	Northern Territory		-19.944	134.341	366
112	YAK	Yakutsk	Yakutskaya		62.017	129.717	125
113	YKC	Yellow Knife	Northwest Territories		62.478	-114.473	198
114	YSS	Yuzh-Sakhalinsk	Sakhalinskaya		47.017	142.717	75
115	ZAK	Zakamensk	Buryatskaya		50.383	103.283	-

Appendix B

Annual statistics of reported events

In this Appendix, information on the reportings in the ISC bulletins by each station is listed by year. The following information is listed:

Name:	Station code
nobs (Arrivals):	Total number of P-arrivals for the station for the years 1971-1980
mavg (Arrivals):	Average ISC-reported magnitudes (m_b) for the events reported
nobs (log A/T):	Total number of P-arrivals with reported log A/T for the station (1971-1980)
mavg (log A/T):	Corresponding average ISC m_b for this set of events
lavg (log A/T):	Average log A/T reported for the station
Annual no. of detections (1971-1980):	Total number of P-arrivals per year (irrespective of whether log A/T was reported) for the station

	Arrivals		****log(A/T)****			*************Annual no. of detections*************									
Name	nobs	mavg	nobs	mavg	lavg	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
ADK	3337	5.38	623	5.43	2.07	386	401	421	386	407	289	263	293	230	261
ALE	7323	5.00	4679	5.04	1.22	888	946	1052	493	784	701	541	729	643	546
ALQ	9937	4.93	4770	4.95	1.11	712	746	878	893	682	663	877	1538	1555	1393
ARE	2422	5.07	279	5.17	1.78	184	204	292	296	263	300	200	219	242	222
ASP	16123	4.98	5385	5.15	1.75	1590	1800	1571	1471	1524	1396	1336	1800	1834	1801
BAG	5155	5.30	1215	5.41	2.15	636	571	504	424	563	440	458	441	444	624
BDF	1325	4.80	271	4.89	1.53	354	383	474	114	0	0	0	0	0	0
BDW	4131	4.93	1466	4.95	1.08	0	0	0	0	0	0	515	1093	1189	1334
BHA	1232	5.22	1191	5.21	1.15	285	230	0	0	253	132	332	0	0	0
BJI	1473	5.17	456	5.24	1.68	0	0	0	0	0	0	0	0	550	923
BKR	7192	5.05	1145	5.12	1.74	538	774	823	766	827	754	737	739	552	682
BLC	5579	4.93	2580	4.96	1.42	698	794	726	929	1101	937	394	0	0	0
BMO	11025	4.73	10615	4.72	0.70	2368	2553	2830	2504	770	0	0	0	0	0
BNG	6408	4.82	6316	4.82	1.11	586	628	699	734	745	598	598	444	647	729
BOD	9094	5.09	1566	5.16	1.49	783	925	866	835	1026	830	969	1027	862	971
BUL	6166	5.04	5804	5.05	1.22	534	523	690	678	672	557	785	453	608	666
CAN	9545	5.15	397	5.31	1.98	916	1010	748	635	925	994	1020	1017	1059	1221
CAR	2066	5.18	1142	5.28	1.86	288	269	284	239	169	185	175	155	164	138
CHG	9180	4.99	2986	5.06	1.39	133	0	131	368	1107	1238	962	1344	1825	2072
CIR	3367	5.12	3164	5.12	1.12	394	367	517	448	405	353	138	225	312	208
CLK	2447	5.17	2361	5.17	1.14	312	176	242	276	106	0	351	321	357	306
CLL	11031	4.93	5343	5.11	1.54	878	956	1183	1082	1386	1275	960	1331	990	990
COL	19219	4.90	8404	5.00	1.40	1968	1844	1842	1798	1874	1904	1748	2065	1841	2335
CPO	4765	4.84	3197	4.86	1.26	840	711	1033	1065	684	194	238	0	0	0
CTA	11796	5.01	918	5.21	1.77	869	1103	1005	966	1043	1111	1176	1200	1523	1800
DAG	8400	4.96	6784	5.00	1.33	0	313	606	776	1303	1156	1227	1096	882	1041
DUG	8100	5.00	2636	5.08	1.31	943	1061	960	635	553	1014	1063	1166	705	0
EDM	11363	4.95	2431	5.30	1.99	1443	1386	1380	1351	1102	1237	889	1036	875	664
EKA	5470	5.04	2473	5.18	1.49	442	486	621	525	698	656	523	658	302	559
ELT	9205	5.06	1459	5.14	1.61	905	989	964	813	1117	990	1008	799	795	825
EUR	13749	4.92	10992	4.96	0.87	1652	1568	1706	1692	1457	1229	1157	1211	1141	936
FFC	9446	4.91	6038	4.96	1.30	987	1055	1169	1064	1060	1074	776	958	801	502
FRB	4455	4.97	601	5.46	2.07	0	0	611	548	625	566	422	719	530	434
FRU	6551	5.16	776	5.29	1.97	632	674	659	554	757	753	670	643	546	663
FVM	2700	5.05	354	4.91	1.47	0	0	0	148	426	293	323	434	513	563
GBA	10880	5.02	4069	4.97	1.25	860	981	688	856	1141	1158	1142	1209	1063	1782
GDH	2462	5.35	1792	5.39	1.57	315	270	260	234	323	260	228	263	153	156
GRF	7660	4.99	3166	5.14	1.66	732	782	842	880	996	986	625	763	518	536
GRR	4723	5.10	2103	5.05	1.34	476	458	510	434	478	475	455	562	474	401
GUA	2172	5.43	1079	5.46	2.48	177	217	234	279	257	175	253	212	180	188
HFS	16232	4.74	13643	4.72	1.07	1091	1273	1919	1651	1909	1552	1325	2064	1645	1803
HYB	6963	5.19	4485	5.26	1.85	785	638	501	481	634	606	740	844	774	960
ILT	10158	5.10	1005	5.32	1.71	790	1013	1011	925	1269	1222	1045	976	903	1004
IMA	6538	5.01	95	4.76	1.06	296	1216	1156	767	111	198	0	632	716	1446
INK	13828	4.92	2229	5.38	1.91	893	1110	1374	1508	1834	1662	1249	1501	1421	1276
IPM	1305	5.16	663	5.31	1.87	0	0	0	0	0	0	0	0	464	841
IRK	5371	5.25	935	5.32	1.61	420	484	448	511	532	538	614	633	530	661
JAY	1687	5.33	91	5.40	2.15	0	0	0	188	203	169	343	308	202	274
KBL	6434	4.98	701	4.90	1.34	1196	1278	1019	750	542	496	0	302	441	410
KBS	3681	5.28	900	5.38	1.81	445	323	328	319	441	314	296	435	367	413
KEV	7418	5.08	3779	5.24	1.55	667	692	749	728	789	831	686	892	691	693
KHC	10106	4.94	4268	5.13	1.42	818	943	1142	953	1165	1045	852	1244	965	979
KHE	4777	5.24	674	5.36	2.01	410	404	361	407	552	569	481	671	497	425
KHO	6311	5.13	117	5.70	2.60	526	720	727	645	842	774	692	606	458	321
KIR	11135	4.94	1369	5.37	2.22	812	1111	1205	1308	1362	1146	1076	1232	866	1017
KJF	15645	4.86	8159	5.04	1.47	1189	1430	1549	1584	1767	1701	1424	1797	1508	1696
KOD	6828	5.14	1712	5.40	1.93	322	425	509	642	921	820	965	867	622	735
KRA	6158	5.13	3036	5.27	1.83	480	542	642	520	712	715	585	778	562	622

	Arrivals		****log(A/T)****			*************Annual no. of detections*************									
Name	nobs	mavg	nobs	mavg	lavg	1971	1972	1973	1974	1975	1976	1977	1978	1979	198Ø
KRP	6243	5.21	97Ø	5.37	2.24	76Ø	799	678	568	561	418	633	653	585	588
KTG	4474	5.17	3163	5.25	1.39	488	451	582	324	681	439	488	439	324	258
LAO	12687	4.65	1Ø717	4.61	Ø.77	1423	245Ø	2926	2894	1614	157	1Ø66	157	Ø	Ø
LEM	53Ø1	5.26	1552	5.23	1.8Ø	379	538	535	5Ø9	654	556	5ØØ	6Ø1	363	666
LOR	6592	5.Ø2	55ØØ	4.99	1.18	565	595	7Ø7	6Ø9	758	678	578	755	7Ø4	643
LPB	46Ø5	4.89	1394	5.Ø3	1.65	317	373	514	514	423	526	374	447	592	525
LPS	1359	5.19	83Ø	5.24	1.62	3Ø2	248	3Ø1	198	Ø	Ø	194	Ø	116	Ø
MAIO	3636	5.Ø4	674	5.28	1.51	Ø	Ø	Ø	Ø	Ø	395	687	576	894	1Ø84
MAT	96Ø2	5.13	34Ø8	5.22	1.62	1Ø73	1Ø95	919	971	1ØØ1	946	922	88Ø	884	911
MAW	5764	5.2Ø	937	5.37	1.67	7Ø6	747	417	433	619	776	579	676	481	33Ø
MBC	177ØØ	4.77	14184	4.76	1.Ø6	1Ø3Ø	1521	1764	2224	22Ø4	1723	1342	2119	2223	155Ø
MIR	3Ø44	5.37	3Ø7	5.57	2.Ø9	517	351	3Ø7	2Ø6	132	381	331	3Ø1	267	251
MNG	6Ø12	5.18	645	5.33	1.92	7Ø3	821	512	568	5Ø3	444	597	6Ø6	668	59Ø
MOX	94Ø4	4.97	5954	5.Ø8	1.22	8Ø2	896	1Ø76	1ØØ9	1233	1Ø64	8Ø7	1Ø39	791	687
MOY	6556	5.18	964	5.26	1.72	468	675	684	642	745	689	722	719	578	634
MSO	6238	5.Ø2	3814	5.Ø7	1.28	Ø	Ø	Ø	91Ø	1167	917	886	959	838	561
MTD	2931	5.11	2675	5.1Ø	1.19	178	286	4Ø4	229	17Ø	225	4Ø1	167	449	422
MTN	729Ø	5.Ø7	173	5.Ø1	1.5Ø	Ø	655	927	1Ø4Ø	1Ø69	879	76Ø	629	519	812
MUN	4892	5.32	5Ø7	5.48	2.14	538	661	478	494	416	45Ø	465	461	368	561
NAO	1Ø819	4.65	1Ø644	4.65	Ø.74	Ø	1633	2235	239Ø	2273	1591	Ø	141	112	444
NDI	7279	5.16	216Ø	5.35	2.Ø3	753	785	657	521	822	731	756	85Ø	689	715
NEW	9757	5.Ø6	1264	5.31	1.52	1126	922	11Ø8	1Ø77	1Ø28	1Ø1Ø	836	1Ø29	855	766
NUR	15Ø61	4.83	735Ø	5.Ø3	1.43	1123	131Ø	15Ø7	15Ø8	1724	17Ø7	1329	1872	1435	1546
NVL	254Ø	5.4Ø	348	5.48	1.81	185	274	224	213	193	279	349	243	282	298
OBN	8196	5.Ø8	1166	5.18	1.8Ø	71Ø	9Ø2	922	8Ø5	979	82Ø	812	812	7Ø6	728
PET	3385	5.4Ø	4Ø2	5.54	2.12	176	323	267	269	4ØØ	378	431	4Ø1	376	364
PMG	5368	5.21	2349	5.19	2.Ø5	531	71Ø	578	462	4Ø8	385	447	61Ø	618	619
PMR	115Ø6	5.Ø7	7882	5.14	1.35	137Ø	1339	1189	1146	1171	1114	1ØØ6	1Ø92	1ØØ4	1Ø75
PNS	1813	4.82	246	4.89	1.52	335	434	549	495	Ø	Ø	Ø	Ø	Ø	Ø
POO	37Ø8	5.33	9Ø8	5.38	1.88	333	379	366	348	395	432	377	423	284	371
PPI	1865	5.21	392	5.37	1.98	Ø	Ø	Ø	Ø	Ø	Ø	Ø	87Ø	552	443
PRE	2995	5.18	2753	5.18	1.33	324	322	348	3Ø1	368	276	397	225	2Ø9	225
PSI	3574	5.Ø9	1296	5.16	1.61	Ø	Ø	Ø	Ø	Ø	172	Ø	1285	1Ø3Ø	1Ø87
QUE	67Ø1	5.Ø3	778	5.15	1.63	879	751	923	768	1Ø44	1ØØ4	232	11ØØ	Ø	Ø
RAB	32Ø1	5.37	247	5.44	2.31	319	454	514	291	489	282	254	251	153	194
RES	821Ø	4.92	7125	4.9Ø	1.22	575	485	627	1Ø45	1261	839	681	11Ø5	893	699
SCH	3323	5.14	847	5.35	1.95	427	37Ø	334	36Ø	328	239	3Ø3	339	317	3Ø6
SES	8Ø27	5.Ø2	1222	5.4Ø	2.Ø4	1294	11Ø6	1112	9Ø5	842	77Ø	538	639	486	335
SHL	7849	5.14	178	5.35	1.97	476	8Ø3	773	619	8Ø7	832	868	899	825	947
SJG	1Ø28	5.21	635	5.24	1.87	246	Ø	2Ø5	185	Ø	Ø	14Ø	125	127	Ø
SPA	1Ø221	5.Ø1	5249	5.Ø9	1.55	1137	1134	749	1196	788	698	1156	887	1288	1188
STK	6929	5.1Ø	1338	5.35	2.12	Ø	Ø	Ø	781	1285	1268	1119	1417	1Ø59	Ø
SVE	6891	5.1Ø	6Ø1	5.33	1.99	619	691	727	748	823	591	535	648	64Ø	869
TIK	9Ø19	5.Ø7	1455	5.15	1.49	833	1Ø95	94Ø	1Ø45	1275	978	Ø	723	999	1131
TOO	8Ø98	5.19	1277	5.37	2.Ø1	76Ø	1Ø27	84Ø	775	757	757	8Ø2	8Ø5	89Ø	685
TPT	2939	5.42	24Ø1	5.42	1.91	315	253	289	35Ø	319	33Ø	288	278	258	259
TUC	9Ø32	5.Ø1	23Ø2	5.13	1.32	959	887	9Ø6	921	8Ø6	834	1Ø1Ø	827	849	1Ø31
TUL	8542	4.89	79Ø2	4.9Ø	1.41	834	757	1Ø84	1Ø27	1Ø61	765	661	761	68Ø	912
TUP	5812	5.13	111	5.16	1.19	373	61Ø	67Ø	634	771	866	685	482	516	2Ø5
TVO	2255	5.48	1658	5.45	2.Ø5	291	22Ø	23Ø	253	23Ø	232	218	188	193	2ØØ
UBO	5466	4.71	3618	4.72	Ø.79	2249	2367	85Ø	Ø	Ø	Ø	Ø	Ø	Ø	Ø
UPP	1Ø726	4.93	1348	5.35	2.2Ø	77Ø	1Ø42	1188	1128	1317	1224	1Ø21	12Ø6	848	982
WRA	14521	4.77	75Ø4	4.64	Ø.91	1462	17Ø2	1546	1361	191	Ø	848	1551	2691	3169
YAK	8127	5.13	861	5.29	2.12	433	876	883	742	971	816	841	851	699	1Ø15
YKC	7542	5.Ø1	2739	5.16	1.5Ø	854	883	847	1Ø67	925	721	527	652	614	452
YSS	5545	5.25	6Ø5	5.4Ø	1.93	353	516	489	5ØØ	568	625	71Ø	575	564	645
ZAK	1Ø922	5.Ø6	2161	5.Ø7	1.3Ø	819	1Ø2Ø	972	1ØØ5	1229	1147	12ØØ	1246	1Ø43	1241

Appendix C

Examples of station threshold estimation

This Appendix is intended to illustrate the estimation procedure used to obtain the station threshold parameters G_i and γ_i (we use the same nomenclature as in the text. The procedure was first developed by Kelly and Lacoss (1969) and has since been applied, e.g., by Lacoss and Chinnery (1976) and Christoffersson (1980). Briefly, the procedure is based on modelling the actually observed log(A/T) values at a given seismic station by a distribution of the form (for simplicity, indices are omitted):

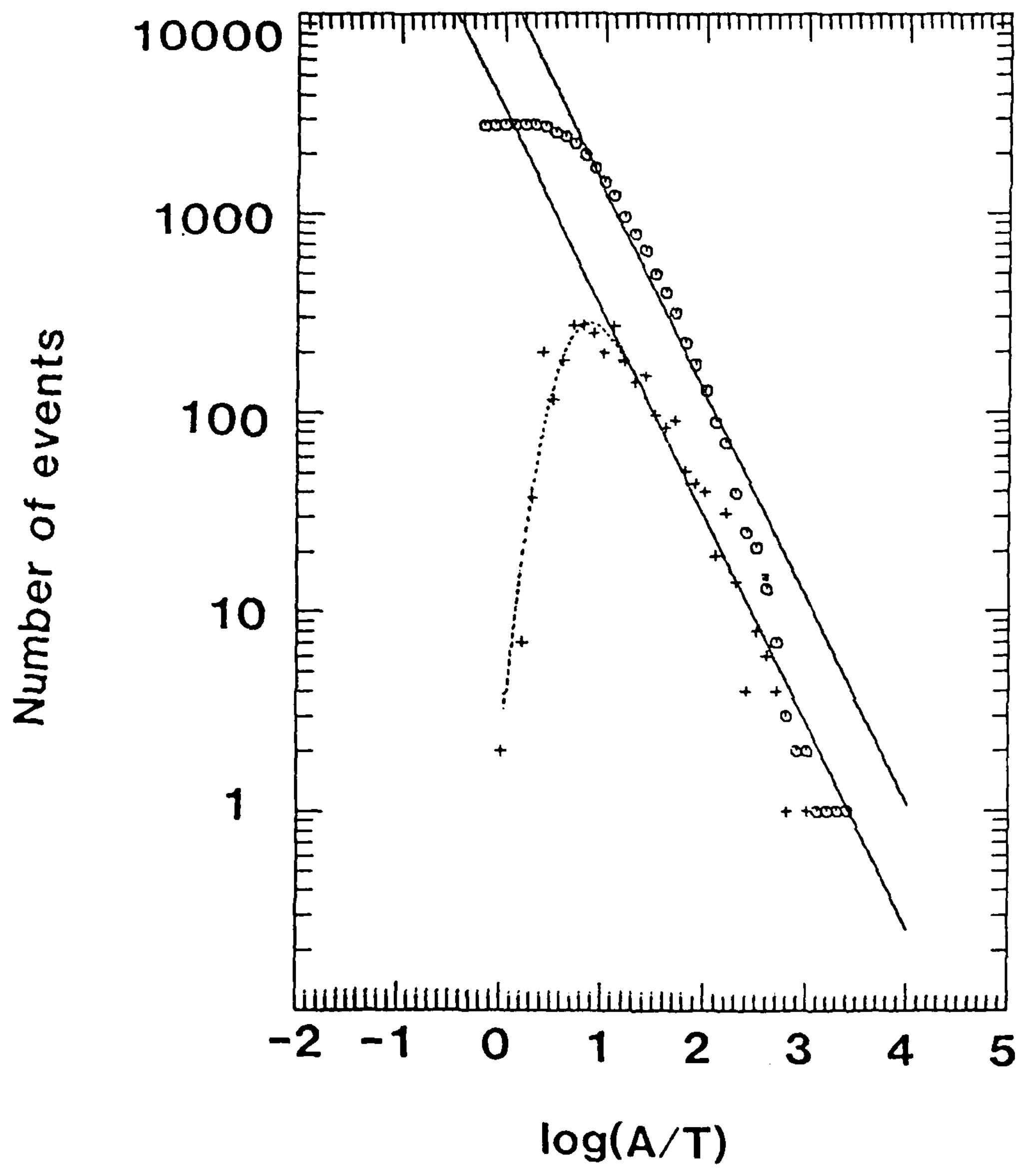
$$d(y) = e^{\alpha-\beta y}\,\Phi\left(\frac{y-G}{\gamma}\right) \tag{C1}$$

The parameters α and β are related to the commonly used parameters a and b of the frequency-magnitude distribution of earthquakes, and are estimated in the Kelly-Lacoss procedure together with the station parameters G and γ by maximum likelihood. In particular they show that the maximum likelihood estimates must satisfy the following equation:

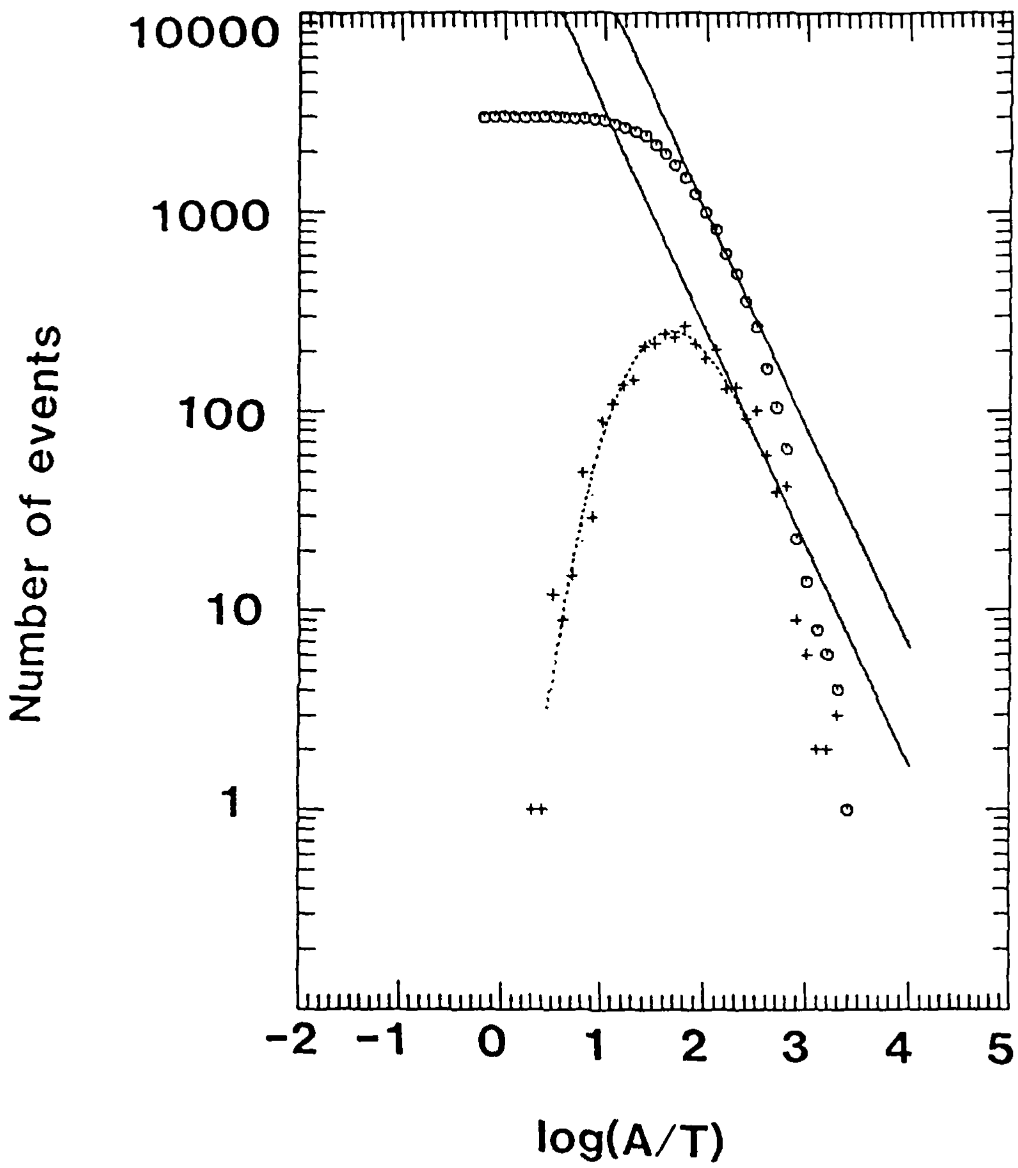
$$G = \bar{y} - \frac{1}{\beta} + \beta\gamma^2 \tag{C2}$$

where $\bar{y}$ is the average observed log(A/T). Their method can also be applied directly to magnitudes (instead of log (A/T)) and thus provides a way to estimate both station and network detection thresholds. When the number of observations is limited, the equation (C2) is often useful to estimate average thresholds directly, assuming that reasonable constraints can be given on β and γ.

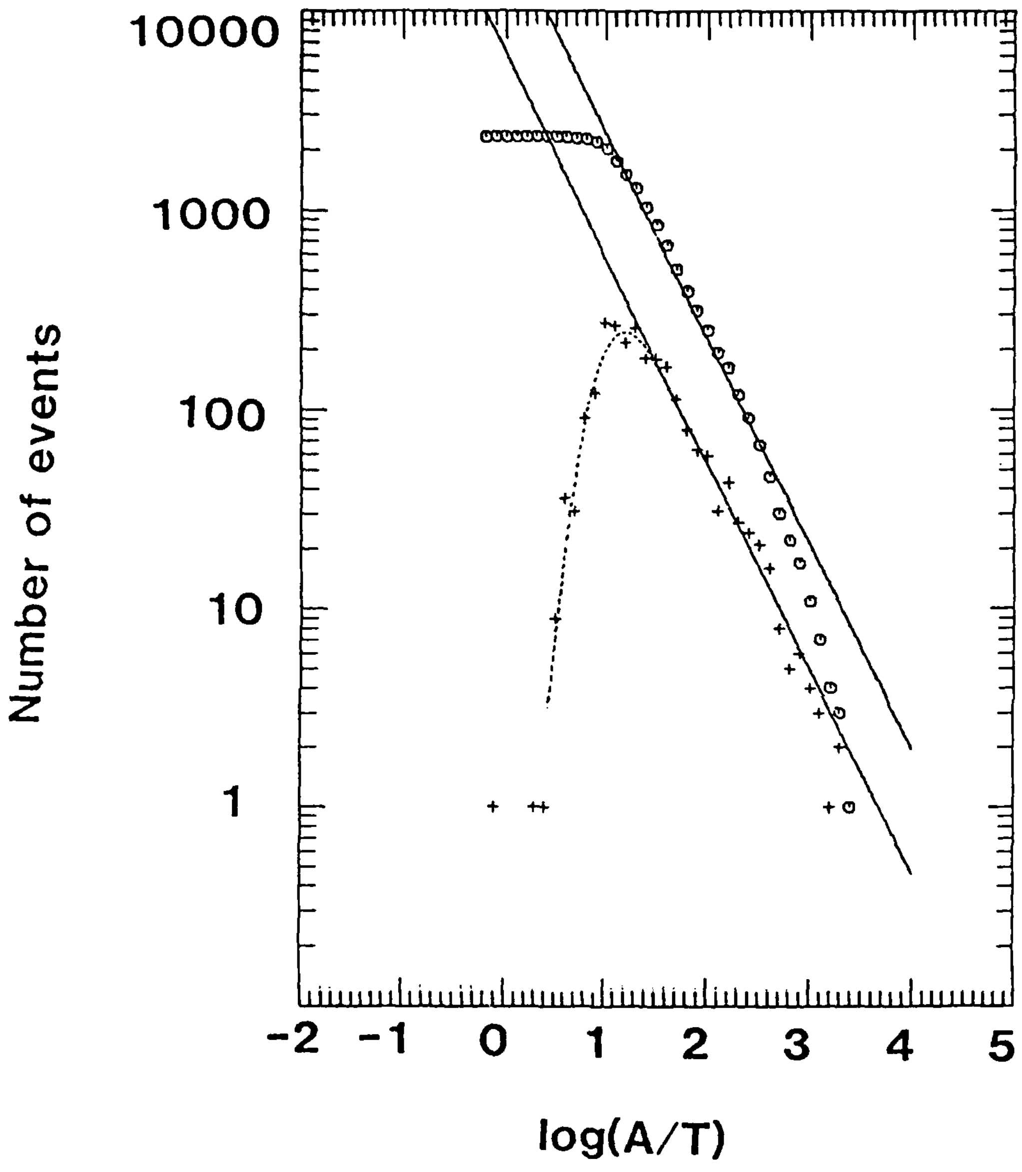
The examples given in the following cover the time interval 1974-79, and are intended to illustrate the fit of the Kelly-Lacoss model to the actual data for representative stations. On each figure, crosses mark incremental number of log A/T reports, circles mark cumulative numbers. The straight lines correspond to the estimated seismicity recurrence, and the dotted lines indicate the fit of equation (C1) to the incremental data points.



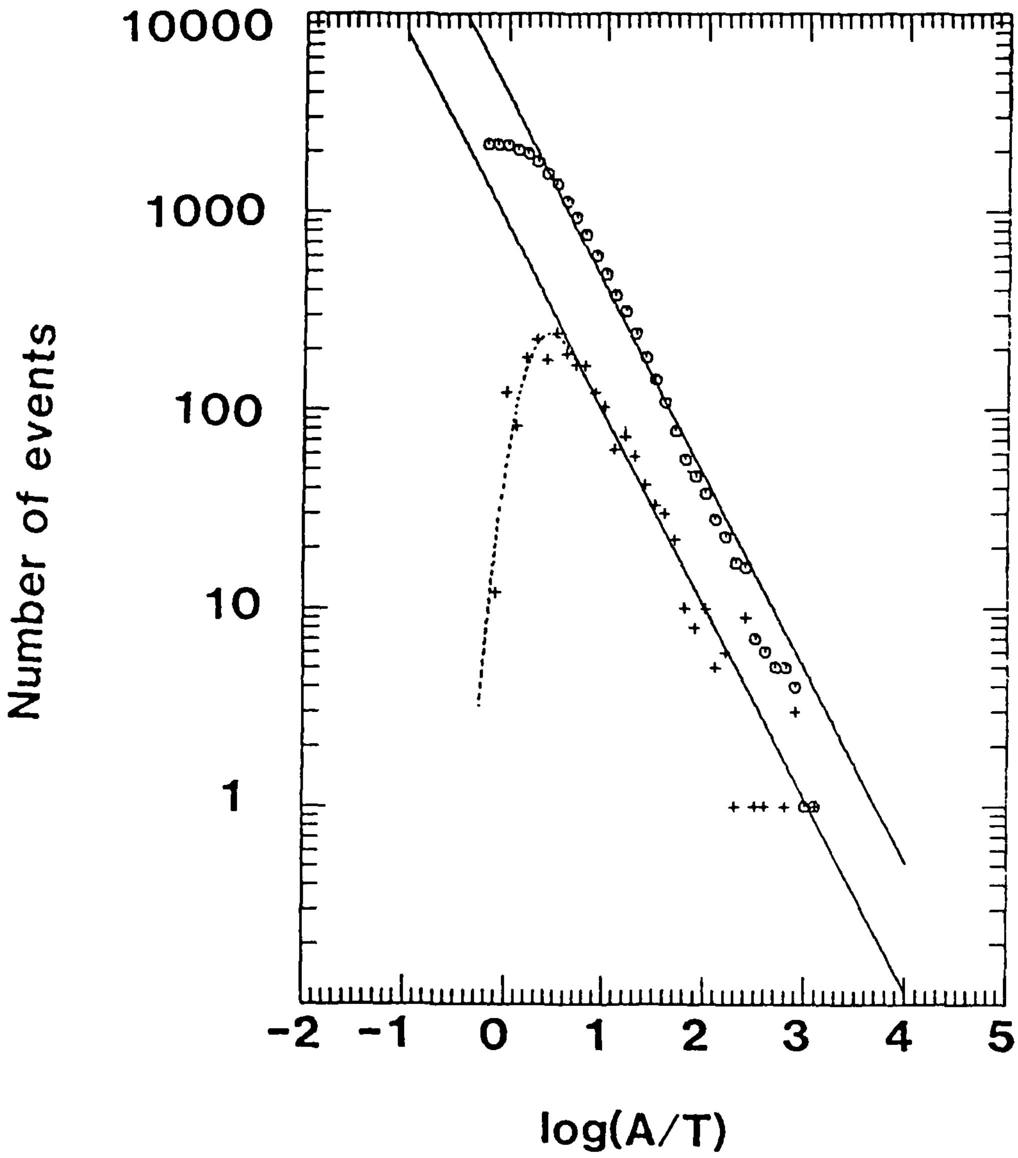
Station ALQ



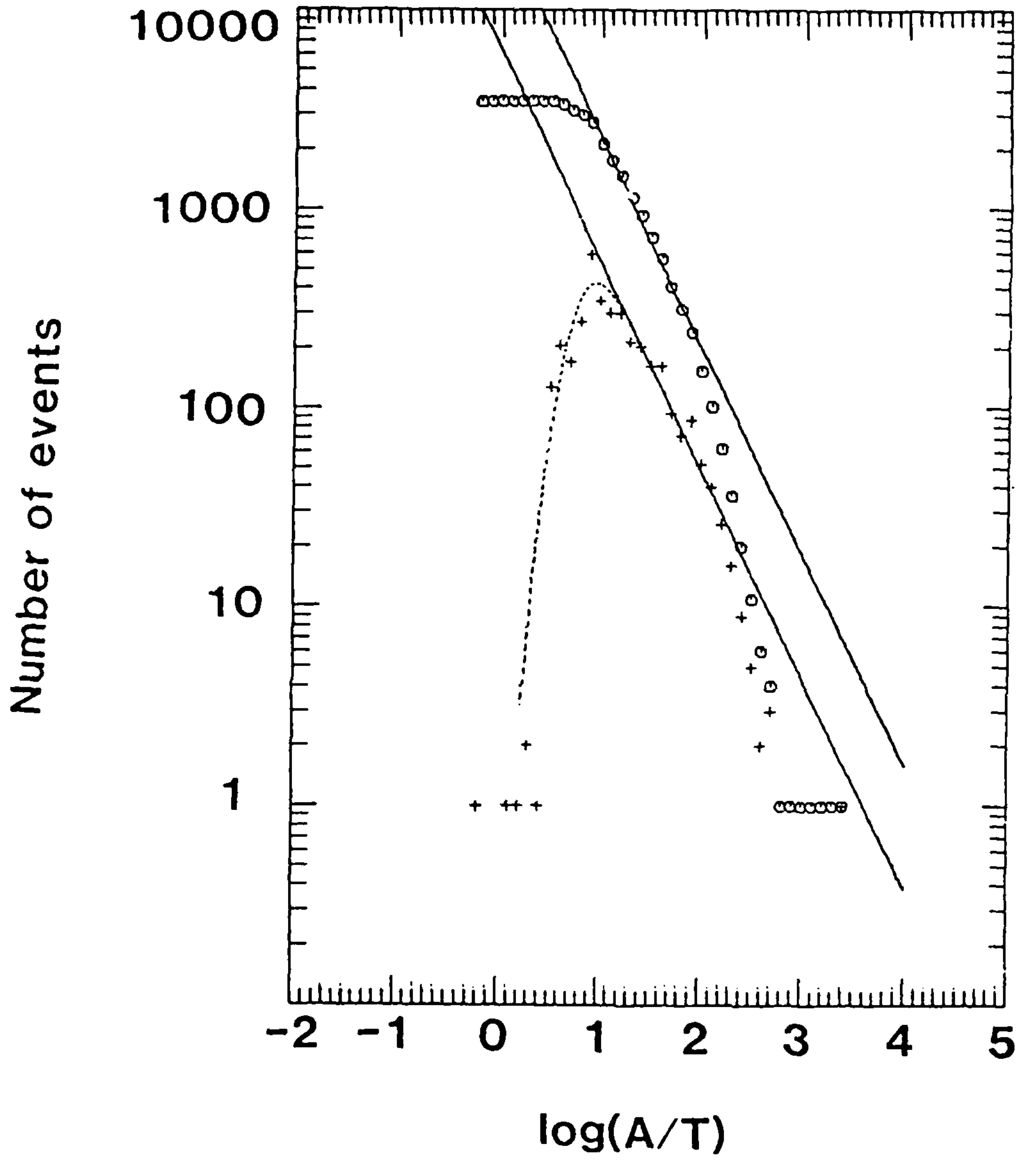
Station ASP



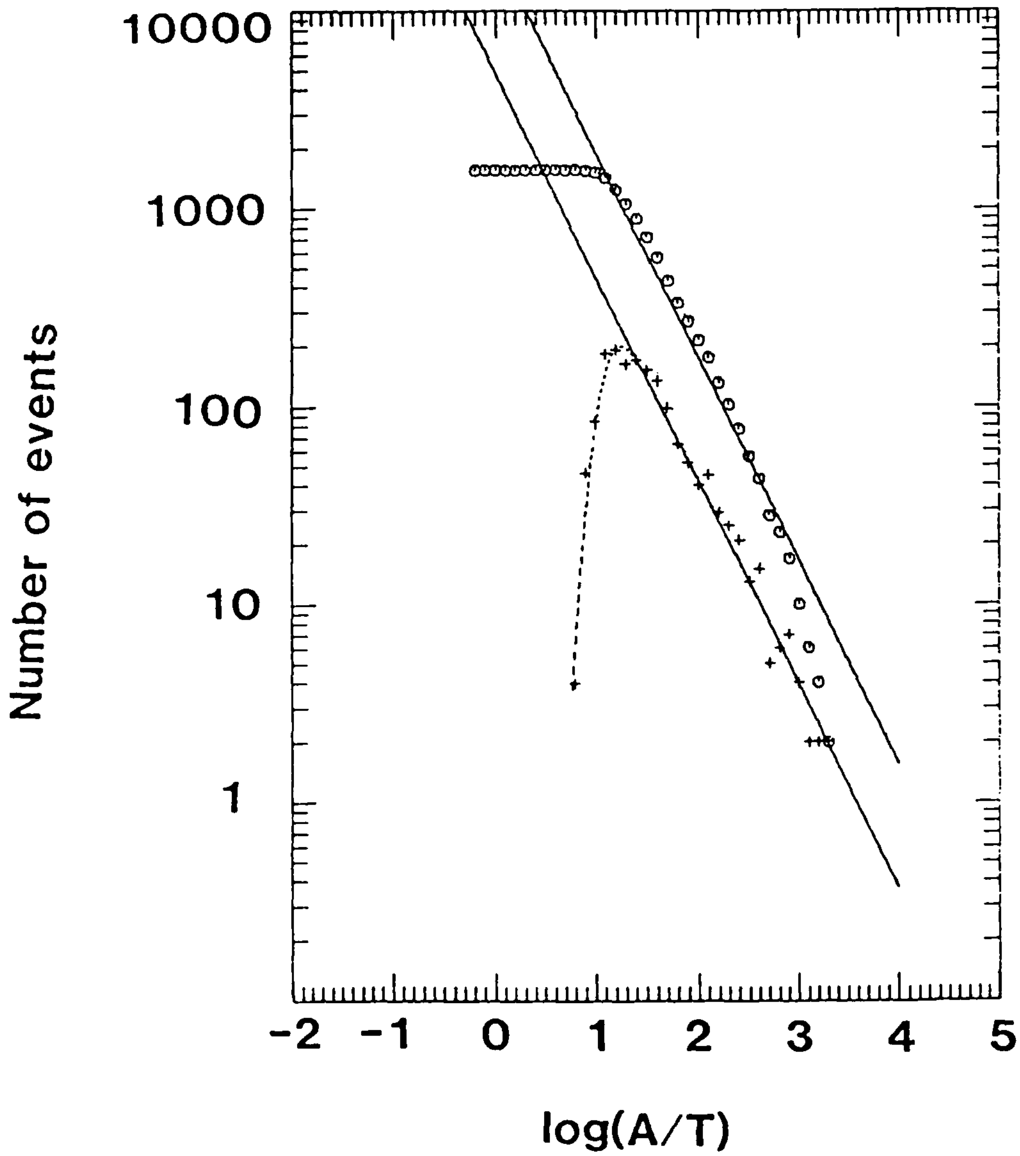
Station BLC



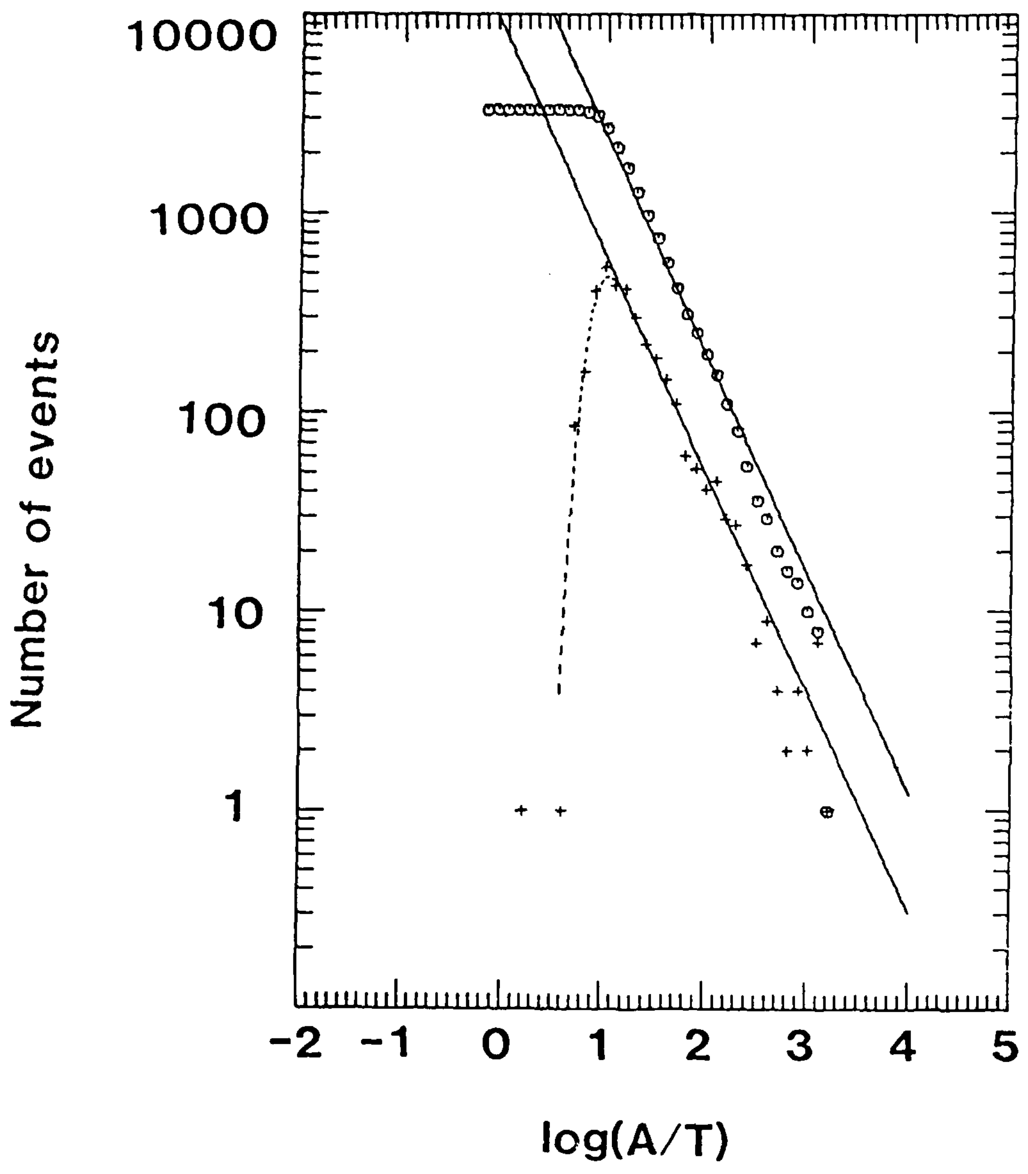
Station BMO



Station BNG



Station BOD



Station BUL

Appendix D

Magnitudes of presumed explosions 1971-1980

In this Appendix, a list is given summarizing some statistics on detection and m_b estimation of presumed explosions in the CSS data base (1971-1980). The estimation procedure described in this paper has been applied to these events, using the subset of the 115 station network in operation at any given time. Note that stations which systematically do not report explosion data have been deleted prior to m_b estimation.

The table contains the following entries, taken from the CSS file unless otherwise specified:

(1) Origin time

(2) Latitude, Longitude, depth

(3) m_b and corresponding number of stations (incomplete in some cases)

(4) m_b, averaged from the 115 station network; after application of station corrections; corresponding number of stations used and standard deviation of m_b within the network

(5) Maximum likelihood m_b (115 station network)

(6) Geographical and seismic region no.

(7) Number of P arrivals (total)

(8) Number of reportings by distance for the 115 station network:
- 0 - 21 degrees
- 21 - 100 degrees
- 100 - 180 degrees

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------ 1 ------- ------2------- ---3--- ------4 ----- --5- ---6---7- ---8---
1971 322 432571 49.7   78.1   0. 5.7  54 5.65  30 0.32 5.67 329 28212  1 50  7
1971 323 659561 61.3   56.2   0. 5.5  47 5.54  30 0.39 5.53 335 29203  6 45 10
1971 425 332571 49.7   78.0   0. 5.9  62 5.85  37 0.27 5.86 329 28236  1 56  7
1971 525 4 2571 49.8   78.2   0. 5.1  21 5.04  17 0.40 4.94 329 28 75  1 33  1
1971 6 6 4 2571 49.9   77.7   0. 5.5  43 5.38  28 0.25 5.39 329 28155  1 53  4
1971 6121914571-23.8-137.1  33. 0.    0 4.54   2 0.   4.58 631 39 14  0  9  2
1971 6161450 01 37.0-116.0   0. 0.    0 0.     0 0.   3.82  41  3  0  8  1  0
1971 619 4 3571 49.9   77.7   0. 5.4  52 5.39  36 0.34 5.40 329 28129  1 52  2
1971 6231530 01 37.0-116.0   0. 0.    0 4.91   1 0.   4.53  41  3  0 10  9  0
1971 62414 0 01 37.1-116.0   0. 0.    0 4.88   4 0.18 4.62  41  3  0 12 15  4
1971 6291830 21 37.0-116.2  25. 4.9   5 4.86   3 0.19 4.73  41  3 62 10 16  3
1971 630 357 21 49.9   79.0  33. 5.2  30 5.18  16 0.38 5.11 329 28115  1 43  1
1971 7 217 0 11 67.6   61.9   0. 4.7   4 4.83   3 0.44 4.36 335 29 29  5 11  0
1971 7 814 0 01 37.1-116.0   0. 0.    0 5.44  21 0.31 5.45  41  3  0 12 37  7
1971 7 81914551 49.9-115.0   0. 0.    0 0.     0 0.   4.00  23  2 15  6  2  0
1971 7101659591 64.1   54.7   0. 5.2  22 5.20  15 0.28 5.04 724 49104  7 33  0
1971 720 833441 56.5    0.8   0. 4.3   3 4.42   3 0.54 4.03 534 36 40 12  3  0
1971 8132059401 49.7-114.6  18. 0.    0 0.     0 0.   0.    23  2  7  3  0  0
1971 8141859591-21.8-138.9   0. 4.7   6 4.85   6 0.16 4.72 631 39 24  0 12  4
1971 8181359591 36.9-116.0   3. 5.3  20 5.25  14 0.23 5.16  40  3130 12 28  8
1971 91911 0 61 57.7   41.4  33. 4.5   6 4.62   5 0.19 4.49 724 49 45 10 13  1
1971 927 559551 73.3   54.9   0. 6.5  63 6.41  29 0.36 6.41 648 40344  7 53 15
1971 9291359581 36.9-116.0   0. 0.    0 0.     0 0.   0.    40  3 28  9  0  0
197110 410 0 21 61.6   47.2  13. 4.6  10 4.75  10 0.28 4.57 724 49 46  6 17  1
197110 81430 01 37.1-116.0   0. 0.    0 0.     0 0.   3.81  41  3  0 10  1  0
197110 9 6 2571 49.9   77.6   0. 5.3  46 5.27  30 0.35 5.31 329 28149  1 55  3
19711014143O 21 37.0-115.9  33. 0.    0 0.     0 0.   0.    41  3 18  8  0  0
19711021 6 2571 50.0   77.6   0. 5.5  49 5.48  32 0.32 5.44 329 28143  0 50  5
19711022 5 0 01 51.6   54.4   6. 5.2  34 5.26  21 0.19 5.18 724 49116  3 40  2
197111 622 0 01 51.4  179.1   0. 0.    0 6.68  25 0.34 6.68   6  1  0  3 62 10
19711129 6 2571 49.7   78.1   0. 5.4  41 5.34  28 0.36 5.27 329 28117  0 45  1
197111301545 31 37.0-116.1  54. 0.    0 0.     0 0.   3.82  41  3 25  9  2  0
1971121421 9591 37.1-116.0   0. 0.    0 0.     0 0.   4.40  41  3  0  9  7  0
19711215 752591 50.0   77.8   0. 4.9   7 4.98   6 0.29 4.51 329 28 31  1 15  0
19711222 659561 47.9   48.0   0. 6.0  50 5.95  28 0.35 5.96 336 29230  4 50 12
19711230 620571 49.7   78.1   0. 5.7  56 5.71  34 0.29 5.73 329 28170  1 52  4
1972 210 5 2571 50.0   78.9   0. 5.4  41 5.43  27 0.32 5.37 329 28151  1 50  6
1972 3 91845 01 32.7-110.4   0. 4.5   2 0.     0 0.   3.76 495 34  0  5  1  0
1972 310 456571 49.7   78.1   0. 5.4  54 5.35  35 0.33 5.36 329 28160  0 55  1
1972 328 421571 49.7   78.1   0. 5.1  35 5.18  23 0.34 5.06 329 28113  0 41  3
1972 33021 0 31 36.9-116.0  35. 0.    0 0.     0 0.   0.    40  3 13  6  0  0
1972 411 6 0 21 37.3   62.0  20. 4.9  16 4.97  12 0.22 4.82 340 29 50  2 27  0
1972 4191632 01 37.1-116.0   0. 0.    0 0.     0 0.   0.    41  3  0  7  0  0
1972 5 21915 21 37.1-116.2  26. 4.7   8 4.68   5 0.34 4.83  41  3 83  8 28  5
1972 5171410 01 37.1-116.0   0. 0.    0 0.     0 0.   4.09  41  3  0  7  3  0
1972 51917 0 01 37.0-116.0   0. 0.    0 0.     0 0.   4.52  41  3  0 10 12  5
1972 6 7 127571 49.7   78.1   0. 5.4  42 5.35  26 0.38 5.21 329 28147  1 46  1
1972 61116 7561 57.0   -6.1   0. 0.    0 4.51   3 0.22 4.19 533 36  0 10  5  1
1972 7 6 1 2581 49.9   77.8   0. 4.4   6 4.46   6 0.36 4.36 329 28 21  1 16  0
1972 7 9 659571 49.7   35.4   0. 4.8   5 4.77   4 0.13 4.58 357 30 62 12 15  0
1972 7141459491 49.9   46.3   0. 0.    0 3.71   2 0.   3.63 357 30  6  1  4  0
1972 7201716 01 37.2-116.1   0. 0.    0 4.90   8 0.19 4.87  41  3  0 10 25  5
1972 7251330 31 36.9-116.1  21. 0.    0 0.     0 0.   3.78  40  3 17  7  1  0
1972 816 316571 49.7   78.1   0. 5.0  30 5.04  20 0.26 4.96 329 28 96  1 40  1
1972 820 259571 49.3   48.0   0. 5.7  46 5.68  28 0.30 5.69 336 29209  4 47  4
1972 826 346561 49.9   77.8   0. 5.3  37 5.34  21 0.30 5.19 329 28135  1 46  3
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------ 1 ------- ------2------- ---3--- ------4 ----- --5- ---6---7- ---8---
1972 828 559561 73.3   54.6   0. 6.3   71 6.27   30 0.31 6.27 648 40333  8 52 16
1972 9 2 856571 49.8   77.6   0. 4.9   10 5.02    8 0.37 4.74 329 28 38  1 27  0
1972 9 4 7 0 41 67.7   33.0   7. 4.6    6 4.79    4 0.30 4.53 724 49 47 11 14  2
1972 921 9 0 11 52.1   51.9  28. 5.0   19 4.97   12 0.26 4.79 724 49 83  4 31  3
1972 9211530 01 37.0-116.0    0. 0.     0 5.52   18 0.25 5.55  41  3  0 11 36  8
1972 9261430 01 37.1-116.0    0. 0.     0 4.00    1 0.   4.11  41  3  0 10  4  1
197210 3 9 0 01 46.9   44.9   0. 0.     0 5.61   31 0.29 5.66 357 30  0  4 52  5
197211 2 126571 49.9   78.8   0. 6.1   75 6.12   38 0.32 6.14 329 28293  1 61 11
19721124 9 0 21 52.1   51.8  33. 4.5    8 4.66    7 0.24 4.47 724 49 40  4 18  1
19721124 959581 51.8   64.1   0. 5.2   37 5.13   27 0.28 5.09 336 29104  1 47  1
19721210 426571 49.7   78.0   0. 5.6   62 5.56   33 0.37 5.59 329 28245  1 54  6
19721210 427 71 49.9   78.9   0. 6.0   26 6.00   15 0.35 5.77 329 28146  0 36  3
197212212015 01 37.1-116.0    0. 0.     0 4.87    5 0.24 4.86  41  3  0 10 22  4
1973 216 5 2571 49.8   78.2   0. 5.5   49 5.46   35 0.34 5.42 329 28162  1 53  4
1973 3 81610 01 37.1-116.0    0. 0.     0 5.24   20 0.16 5.22  41  3  0 11 35  9
1973 419 432571 49.9   77.6   0. 5.4   40 5.32   31 0.32 5.25 329 28140  0 49  3
1973 4252225 01 37.0-116.0    0. 0.     0 4.38    2 0.   4.40  41  3  0 10  9  0
1973 4261715 01 37.1-116.0    0. 0.     0 5.46   19 0.24 5.48  41  3  0 10 41  8
1973 51716 0 01 39.7-108.3    0. 0.     0 5.20   16 0.23 5.19 479 34  0 12 32  2
1973 5241330 21 37.2-116.1    5. 0.     0 0.      0 0.   3.76  41  3 18  8  1  0
1973 6 517 0 01 37.1-116.2    0. 0.     0 4.99   10 0.28 4.90  41  3  0 11 24  5
1973 6 613 0 01 37.2-116.3    0. 0.     0 6.03   27 0.27 6.01  41  3  0 11 39 16
1973 627 359451 40.6   89.6   0. 4.8   14 4.69   10 0.25 4.44 321 27 33  1 16  0
1973 6281915121 37.1-116.0    0. 0.     0 4.89    8 0.10 4.85  41  3  0 11 23  4
1973 710 126581 49.8   78.0   0. 5.2   39 5.23   26 0.35 5.08 329 28130  1 42  0
1973 723 122571 49.9   78.8   0. 6.1   81 6.21   41 0.38 6.21 329 28291  1 64  8
1973 815 159571 42.6   67.4   0. 5.3   47 5.33   28 0.32 5.21 713 48151  3 43  3
1973 828 259571 50.5   68.3   0. 5.2   27 5.14   22 0.29 4.97 713 48 82  2 36  0
1973 912 659541 73.3   54.9   0. 6.8   53 6.67   20 0.45 6.67 648 40399  8 58 17
1973 919 259571 45.6   67.7   0. 5.1   21 4.99   15 0.32 4.96 713 48 98  3 38  0
1973 927 659581 70.8   53.4   0. 5.9   57 5.90   30 0.25 5.91 648 40237  9 51 10
1973 930 459571 51.6   54.5   0. 5.2   43 5.20   30 0.26 5.11 724 49134  2 44  2
1973101217 0 01 37.2-116.1    0. 0.     0 4.68    6 0.18 4.60  41  3  0  7 15  4
19731026 426571 49.7   78.1   0. 5.2   39 5.22   30 0.33 5.11 329 28117  0 44  1
19731026 559571 53.6   55.3   0. 4.8   17 4.86   12 0.33 4.64 335 29 65  3 24  0
19731027 659571 70.7   53.9   0. 6.9   61 6.69   26 0.47 6.69 648 40387  9 52 17
19731027 8 3581 71.0   52.6   0. 4.5    4 4.56    3 0.29 4.02 648 40 13  7  3  0
19731027 821211 70.9   52.5   0. 4.6    5 4.72    4 0.13 4.19 648 40 18  6  6  0
19731027 913511 71.2   51.7   0. 4.6    8 4.92    5 0.19 4.45 648 40 26  7 11  0
197311281530 01 36.9-116.0    5. 0.     0 4.26    2 0.   3.92  40  3 18  8  2  0
1973121219 0 31 36.9-116.0   26. 4.4    3 4.24    2 0.   4.30  40  3 30  8  7  0
19731214 746571 50.0   79.0   0. 5.8   67 5.78   40 0.43 5.80 329 28222  0 64  7
1974 130 456571 49.8   78.0   0. 4.9   13 4.94   10 0.43 4.70 329 28 56  1 25  1
1974 130 457 21 49.8   78.1   0. 5.4   36 5.30   24 0.23 5.14 329 28135  0 43  0
1974 22717 0 01 37.1-116.0    0. 5.8    0 5.58   24 0.27 5.58  41  3  0 13 37  9
1974 516 3 2571 49.7   78.1   0. 5.2   47 5.21   35 0.35 5.20 329 28135  1 52  1
1974 518 234551 26.9   71.7   0. 4.9   14 4.96   13 0.25 4.79 308 26 53  5 21  0
1974 5231338291 37.0-116.1    0. 4.8   13 4.74    9 0.18 4.61  41  3 76 11 16  5
1974 531 326571 49.9   78.9   0. 5.9   83 5.84   47 0.37 5.85 329 28251  0 62  6
1974 617 559521 40.5   89.6   0. 4.5    4 4.49    4 0.10 4.24 321 27  9  1  8  0
1974 61916 0 01 37.1-116.2    5. 4.8   14 4.77   11 0.21 4.77  41  3 97 10 25  4
1974 625 356581 49.9   78.1   0. 4.7    8 4.69    8 0.30 4.42 329 28 28  0 16  0
1974 7 8 559591 53.6   55.0   0. 4.6   11 4.73    7 0.56 4.39 335 29 41  3 15  0
1974 710 256571 49.7   78.1   0. 5.2   47 5.19   33 0.29 5.09 329 28119  1 45  1
1974 71016 0 01 37.0-116.0    0. 5.7    0 5.64   30 0.25 5.62  41  3  0 15 40 11
1974 722 132221 70.7   53.3   0. 4.5    5 4.43    4 0.14 4.00 648 40 17  7  4  0
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------ 1 ------- ------2------- ---3--- ------4 ----- --5- ---6---7- ---8---
1974 81414 0 01 37.0-116.0   0. 4.6    0 0.      0 0.   4.01  41   3  0  8  2  0
1974 814145958l 68.9   75.8   0. 5.4   53 5.36   32 0.30 5.23 725 49162  4 44  1
1974 829 959551 73.4   54.9   0. 6.4   67 6.29   30 0.45 6.30 648 40353  8 48 16
1974 8291459581 67.2   62.1   0. 5.0   21 5.04   17 0.26 4.84 335 29 78  6 28  1
1974 83015 0 01 37.1-116.0   0. 5.8    0 5.57   30 0.39 5.55  41   3  0 16 38  7
1974 913 3 2571 49.7   78.0   0. 5.2   40 5.11   30 0.29 5.00 329 28 97  0 41  1
1974 92514 0 01 36.9-116.0   5. 0.     0 4.14    2 0.   3.98  40   3 18  7  3  0
1974 92615 5 01 37.1-116.0   0. 5.6    0 5.37   20 0.27 5.26  41   3  0 15 33  6
19741016 632571 49.9   78.9   0. 5.5   63 5.50   35 0.42 5.52 329 28171  0 56  3
197411 2 459561 70.8   53.9   0. 6.4   87 6.43   28 0.48 6.43 648 40402  9 54 17
197412 7 559561 49.9   77.6   0. 4.7    4 4.67    4 0.29 4.27 329 28 23  1 12  0
19741216 622571 49.8   78.0   0. 5.0   26 4.99   23 0.34 4.89 329 28 70  1 38  0
19741216 640571 49.8   78.1   0. 4.8   24 4.86   18 0.42 4.72 329 28 71  1 31  0
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1975 3 715 0 01 37.1-116.0   0. 0.     0 5.44   26 0.22 5.37  41   3  0 15 33  6
1975 311 542571 49.7   78.2   0. 5.4   56 5.34   38 0.33 5.31 329 28146  0 54  0
1975 31721 6 71 50.2-114.8   0. 0.     0 4.01    1 0.   3.67  24   2 15  8  1  0
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197510241711261 37.2-116.1   0. 0.     0 4.78   10 0.35 4.68  41   3  0 10 20  2
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1976 320 4 3391 50.0   77.3   0. 5.1  45 5.09  22 0.29 4.92 329 28128   1 39  1
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19761017 5 0 31 41.6   88.2  33. 4.9  18 5.00  13 0.23 4.78 321 27 56   4 28  1
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1977 329 356571 49.7   78.1   0. 5.4  60 5.31  36 0.32 5.24 329 28172   0 51  2
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1977 425 4 6581 49.8   78.1   0. 5.1  46 5.15  19 0.34 4.90 329 28 92   1 34  0
1977 42715 0 01 37.0-116.0   0. 0.    0 5.31  23 0.21 5.25  41   3   0 12 34 10
1977 5251659591 37.0-116.0   0. 5.3  58 5.24  28 0.25 5.24  41   3205 13 37  8
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1977 730 156571 49.7   78.0   0. 5.1  58 5.18  24 0.26 4.96 329 28118   1 37  1
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1977 8202159581 64.1   99.6   0. 5.0  52 5.02  28 0.37 4.88 726 49133   0 40  2
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1977 9 5 3 2571 50.0   78.9   0. 5.8  97 5.88  43 0.30 5.89 329 28322   1 58  5
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197711 118 6 01 37.1-116.2   0. 0.    0 6.34   1 0.   4.18  41   3   0   3  1  1
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explosions Page 5

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19771130 4 6571 49.9   78.8  0. 6.0   90 5.91  41 0.35 5.91 329 28298    1 63  2
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19771226 4 2571 49.8   78.1  0. 4.9   38 4.88  15 0.21 4.61 329 28 69    1 25  0
1978 2132152591 37.0-115.9   2. 0.     0 3.72   1 0.   3.56  41   3 17   6  1  0
1978 22317 0 01 37.1-116.0   0. 0.     0 5.61  29 0.21 5.63  41   3  0  11 34 11
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1978 4111745 01 37.2-116.3   0. 0.     0 5.41  26 0.25 5.40  41   3  0  10 35 11
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19791024 559561 47.7  48.1   0. 5.8  107 5.77  39 0.36 5.79 336 29315   5 52  7
19791028 316571 49.9  79.0   0. 6.0  127 5.96  46 0.38 5.97 329 28326   1 64  4
1979112915 0 01 36.9-116.0   0. 3.8    0 3.71   1 0.   3.56  40  3 12  2  1  0
19791130 452571 49.8  78.2   0. 4.5   20 4.66   8 0.41 4.52 329 28 41   0 22  0
197912 2 436571 49.8  78.8   0. 6.0  118 6.06  42 0.48 6.08 329 28298   2 61  5
19791221 441571 49.8  78.2   0. 4.7   20 4.64   8 0.14 4.43 329 28 36   1 16  0
19791223 456571 49.9  78.7   0. 6.2  116 6.17  40 0.39 6.18 329 28304   2 53  4
1980 22815 0 01 37.1-116.0   0. 4.4    0 4.37   2 0.   4.07  41  3 21  7  3  0
1980 3 81535 01 37.1-116.0   0. 3.9    0 3.81   1 0.   3.62  41  3 23  4  1  0
1980 3231936581-21.8-138.9   0. 5.7   20 5.61  15 0.29 5.66 631 39153   0 28 21
1980 4 11930581-21.7-138.8   0. 5.1    8 5.09   5 0.34 4.89 631 39 65   0 15 15
1980 4 314 0 01 37.1-116.0   0. 4.7    0 5.05  10 0.35 4.85  41  3 80  9 20  4
1980 4 4 532571 49.9  77.8   0. 4.9   26 4.89  11 0.47 4.65 329 28 58   1 24  0
1980 4 41832571-22.1-138.6   0. 4.5    2 4.60   1 0.   4.52 631 39 15   0  6  3
1980 410 4 6571 49.8  78.0   0. 5.0   47 5.00  22 0.35 4.75 329 28105   5 35  0
1980 41620 0 01 37.1-116.0   0. 5.3    0 5.31  22 0.33 5.26  41  3165 11 32  7
1980 425 356571 49.9  78.8   0. 5.5  103 5.54  43 0.42 5.59 329 28225   2 59  2
1980 42617 0 01 37.2-116.4   0. 5.4    0 5.47  23 0.30 5.42  41  3208 13 33  9
1980 5 21846301 37.0-116.0   0. 4.4    0 4.45   3 0.11 4.14  41  3 35  8  4  0
1980 522 356571 49.7  78.1   0. 5.5   75 5.40  38 0.43 5.27 329 28176   2 51  1
1980 612 326571 49.9  79.0   0. 5.6   91 5.64  40 0.42 5.66 329 28242   2 52  5
1980 6121715 01 37.2-116.4   0. 5.6    0 5.50  28 0.31 5.54  41  3201 10 33 13
1980 6161826581-21.8-138.9   0. 5.4   16 5.33  10 0.28 5.06 631 39 81   0 18 12
1980 6241510 01 37.0-116.0   0. 4.4    0 4.41   1 0.   4.10  41  3 26  6  4  0
1980 629 232571 49.9  78.8   0. 5.7   88 5.84  35 0.37 5.86 329 28228   2 52  4
```

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------ 1 ------- ------2------- ---3--- ------4 ----- --5- ---6---7-  ---8----
1980 7 61726591-21.7-138.9   0. 4.6    4 4.45    2 0.    4.41 631 39 17   0  5  4
1980 7192346581-21.8-139.0   0. 5.8   30 5.69   19 0.37 5.73 631 39184   0 33 23
1980 72519 5 01 37.2-116.4   0. 5.5    0 5.45   25 0.23 5.32  41   3178 10 31  8
1980 731 332571 49.8  78.1   0. 5.3   77 5.26   34 0.34 5.17 329 28158   1 48  1
1980 7311819 01 37.0-116.0   0. 4.3    0 4.21    1 0.    3.96  41  3 23   6  2  0
1980 914 242391 49.9  78.8   0. 6.2  104 6.15   42 0.40 6.13 329 28362   2 63  7
1980 925 621101 49.8  78.0   0. 4.7   32 4.67   10 0.21 4.40 329 28 55   1 17  0
1980 9251445 01 37.0-116.0   0. 4.6    0 4.52    2 0.    4.10  41  3 27   8  3  0
198010 8 559571 46.7  48.2   0. 5.2   62 5.30   25 0.30 5.05 357 30142   4 34  4
19801011 7 9571 73.3  54.8   0. 5.7   87 5.69   26 0.28 5.70 648 40297   8 38  9
19801012 334141 49.9  79.1   0. 5.9  118 5.90   44 0.34 5.91 329 28320   2 58  4
198010241915 01 37.0-115.9   0. 4.4    0 4.57    1 0.    3.86  41  3 26   8  1  0
1980103118 0 01 37.2-116.2   0. 4.7    0 4.81    7 0.20 4.65  41  3 77  10 16  5
198011 11259581 60.7  97.5   0. 5.2   59 5.21   33 0.37 5.11 726 49153   0 50  1
198011141650 01 37.1-116.0   0. 4.1    0 0.      0 0.    3.84  41  3 24   8  1  0
198012 31732581-21.8-138.9   0. 5.6   22 5.61   11 0.31 5.55 631 39146   0 23 15
19801210 659571 61.7  66.7   0. 4.6   14 4.72    8 0.26 4.53 725 49 47   3 20  0
19801214 347 61 49.8  78.9   0. 5.9  115 5.99   39 0.45 6.00 329 28307   1 54  3
198012171510 01 37.3-116.3   0. 5.1    0 5.13   13 0.21 4.82  41  3 94   7 19  3
19801226 4 7 71 49.9  78.0   0. 4.5    5 4.46    5 0.40 4.30 329 28 19   0 13  0
19801227 4 9 81 50.0  79.0   0. 5.9   90 5.88   44 0.45 5.88 329 28259   1 59  3
```

Appendix E

Data file formats

This Appendix specifies the formats of data files developed for the purpose of this study. These files are available at the CSS.

Magnitude Data Files 1971-1980.

1. Station file (115 station network).

This file, named 'glnet.115', contains 115 records, each of which is formatted as follows:

Byte:	Format:	Contents:
1-4	i4	Station No.
5	1x	
6-9	a4	Station Code (ISC)
10-15	f6.2	Station threshold G (in terms of log(A/T))
16-21	f6.2	Associated standard deviation
22-27	f6.2	Station bias B (mb units)
28-33	f6.2	Associated standard deviation
34-42	f9.3	Station latitude,degrees (+ means North)
43-51	f9.3	Station longitude,degrees (+ means East)
52-56	i5	Station altitude, meters
57	a1	'W' indicates WWSSN station
58-101	a44	Alphanumeric station name (ISC)

2. Event data files (115 station network).

There are 10 such files, one for each year. They are named 'ev1971','ev1972',etc. up to 'ev1980'. Each file consists of about 7000 event records, for a total of about 2M bytes for each year of data. All ISC-reported events with at least one teleseismic detection have been included. Each event record gives information on origin time, ISC location, magnitudes (including MLE) and complete station detection information for the 115 station network. The format of each record is as follows:

Byte:	Format:	Contents:
1-4	i4	Year
6-6	i2	Month
7-8	i2	Day
9-10	i2	Hour
11-12	i2	Minute
13-14	i2	Second
15	i1	'1' for events in the Ingres EXPLOSION file
16-20	f5.1	Latitude, degrees (+ means North)
21-26	f6.1	Longitude, degrees (+ means East)
27-31	f5.0	Depth, km
32-35	f4.1	ISC mb
36-39	i4	No of observations for ISC mb
40-44	f5.2	Bias-corrected conventional mb : 115 stations
45-48	i4	Associated no of log(A/T) observations
49-53	f5.2	Associated standard dev. of station mb values
54-58	f5.2	Maximum likelihood mb
59-62	i4	Flinn-Engdahl region no
63-65	i3	Gutenberg-Richter region no
66-68	i3	Total no of ISC P-arrivals
69-77	3i3	Counts of local,teleseismic and core detections (includes both arrays and associated stations)
78-307	115i2	One entry for each network station: -1 : Station not listed by ISC as operational 0 : Station listed, but no reported arrival 1 : Station reported arrival without log(A/T) >1 : 10*log(A/T)+30 for the station

3. Complete ISC amplitude data files.

There are 12 such files per year (one per month), named 'i71JAN','i71FEB', etc. up to 'i80DEC'. (The month is indicated by its first three letters, capitalized). These files are very voluminous, comprising about 0.5M bytes per month for a total of 60M bytes for the 10 years.

It has not been my intention to develop these files for general use, since I have been aware that efforts are currently underway to include these data together with arrival times in the Ingres system. However, until that project has been completed, these files may be quite useful to some research projects, and I therefore enclose a brief description. For additional aid in reading the files, reference is made to the FORTRAN program 'netmle.f' residing in my directory. I also suggest that anyone wishing to use these data files contact me for more detailed information.

One month's file contains the following information:

a) File header record :

File name, year, month

b) Station definition records:

One record for each station reporting for the actual month:

Byte 1-4 : station no (i4)
Byte 5-8 : station code (a4)
Byte 9-50: station coordinates (ISC format)

This set of records ends with '9999' in Byte 1-4.

c) Event records:

One event header record followed by zero or more station report records, and ending with '9999' in Byte 1-4.

The event header record contains:

Byte 1-16 : Origin time (ISC tape format)
Byte 17-42: Hypocentral information (ISC format)
Byte 43-73: mb,region no, no of stations (ISC format)

The station report records (one per detecting station) contain:

Byte 1-4 : Station no, corresponding to b) above (i4)
Byte 5-7 : Epicentral distance, degrees (i3)
Byte 8-10 : 10*log(A/T), or '-98' if no log(A/T) report (i3)